

**National Park Service  
Channel Islands National Park**

***ISLAND FOX RECOVERY PROGRAM  
2004 ANNUAL REPORT***

**Technical Report 05-07**

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*Island fox released from captivity on  
San Miguel Island, 2004*

## Executive Summary

From 1995 to 2000, island fox (*Urocyon littoralis*) populations on San Miguel, Santa Rosa and Santa Cruz Islands declined by as much as 95% due to predation by golden eagles (*Aquila chrysaetos*). Faced with the likely extinction of 3 island fox subspecies, the National Park Service began implementing recovery actions for island foxes on the northern Channel Islands in 1999. Such actions included removal of golden eagles and captive breeding of island foxes. In this report we describe progress in island fox recovery in 2004.

### Overall Summary

The most important factor impacting island fox recovery on the northern Channel Islands in 2004 was golden eagle predation, which affected survivorship of both wild-born foxes and foxes released to the wild from captivity. In 2004, 3 adult eagles were captured on Santa Cruz Island and relocated to the California mainland. However, up to 5 adult eagles remained on Santa Cruz Island at the end of 2004 trapping efforts, and both adults of a breeding pair on Santa Rosa Island remained. Survival of wild island foxes on Santa Cruz Island continued to increase in 2004, but effects of predation on foxes released to the wild on Santa Rosa Island were significant. Five of 13 foxes released to the wild in fall 2004 were killed by eagles, whereas only 1 of 12 foxes released to the wild in fall/winter 2003/2004 was killed by eagles. Of the 10 foxes released to the wild on San Miguel Island in fall 2004, none had been killed by eagles as of 15 June, 2005.

Low reproductive success in captivity was a second factor affecting the trajectory of recovery. Although 19 pups were produced in captivity on Santa Cruz Island in 2004, only 12 pups were produced on San Miguel, and 9 on Santa Rosa. Although captive populations were at or above levels allowing release to the wild, production on San Miguel and Santa Rosa did not meet rates required for recovery. Production of 12-20 foxes is required annually to meet the augmentation rate necessary for recovery of each subspecies within a decade (Coonan 2003). In 2004, as in other years, there was a general failure of captive-born females to produce litters. In contrast, released foxes reproduced well in the wild in spring 2005; at least 6 pups were born in the wild on San Miguel, and at least 8 on Santa Rosa.

### San Miguel Island Foxes

The captive population of San Miguel island foxes (*U. l. littoralis*) grew from 38 to 50 individuals with the addition of 12 pups in spring 2004. Four of 15 pairs produced litters. The San Miguel population remains skewed toward males (27 males:23

females). No new founders bred in 2004, and thus 7 of 14 potential founders (wild-born foxes) have successfully bred since 1999. Production in spring 2004 was sufficient to allow initial releases to the wild in fall 2004. Ten foxes (6 males:4 females) were released to the wild in October-November 2004, and all were alive as of 01 August, 2005. Three of the 4 released females produced litters in the wild, for a total of at least 6 wild-born pups. Two female adult foxes died in captivity in spring 2005, and there were 38 adults in captivity.

#### Santa Rosa Island Foxes

The captive island fox population on Santa Rosa Island (*U. l. santarosae*) grew to 54 foxes in spring 2004 with the addition of 9 pups, and the death of 2 foxes in captivity. As on San Miguel, 4 of 15 pairs produced litters. At the end of spring 2004 there were 8 foxes in the wild on Santa Rosa: 6 from the releases in fall 2003 - winter 2004, and 2 female pups born in the wild to Male 03 and Female 106. One of those wild female pups was brought into captivity in summer 2004, because her dam is a new founder for the Santa Rosa population. Twelve of 14 potential founders have bred successfully on Santa Rosa Island. Thirteen captive foxes were released to the wild in fall 2004. As of May 15, 2005, 5 foxes released in fall 2004 had died from eagle predation, and 1 fox from the previous year's release (Male 03) had died when he became stuck in a vertical PVC sprinkler pipe near one of the ranch houses in the Becher's Bay area. In spring 2005, 3 released females produced litters in the wild, for a total of at least 8 wild-born pups. As of 01 August, 2005, there were 14 adult foxes in the wild, and 42 adults in captivity.

#### Santa Cruz Island Foxes

Unlike on San Miguel and Santa Rosa Islands where all remaining island foxes were brought into captivity, there is an extant wild population of Santa Cruz Island foxes (*U. l. cruzae*) numbering around 100. Due to the considerable number of golden eagles remaining on the island following eagle removal efforts in 2004 (see below) and the loss to predation of 7 of 12 foxes released in 2002-2003, no foxes were released to the wild on Santa Cruz Island in fall 2004. Thus all 19 pups produced in captivity in spring 2004 were retained, and the captive population grew to 42 animals. A second facility was completed in the Central Valley in 2004 to house the additional animals.

To monitor survivorship among wild foxes and the influence of predation on Santa Cruz Island, The Nature Conservancy funds a radiotelemetry study implemented by the Institute for Wildlife Studies. By the end of 2004 the sample of radiocollared animals exceeded 70 foxes, and annual survivorship was 86%. Eight radiocollared foxes died from predation in 2004.



#### Removal of Golden Eagles

In 2004 staff from the Santa Cruz Predatory Bird Research Group (SCPBRG) completed a 5-year effort to remove golden eagles from the northern Channel Islands. A total of 6 golden eagles (2 adult males, 1 adult female, and 3 nestlings) were removed from the islands in 2004, bringing the total removed over the 5-year period to 37 eagles. Males comprised the bulk (20) of the 29 non-hatchling eagles removed since 1999, and breeding females proved especially difficult to capture; only 4 breeding females were captured in the 5-year period, compared to 13 breeding males. As many as 12 eagles remained on the islands at the end of 2004. The remaining birds included 6 adult females, 3 adult males and 3 subadults. Eagle removal efforts will continue in 2005.

#### Health of Captive Island Foxes

Two female San Miguel island foxes died in captivity in spring 2005, of septicemia subsequent to mastitis. Two Santa Rosa island foxes died in captivity in 2004, one from penmate aggression (she had been housed with 3 other adult females) and one from chronic kidney failure. One adult female died on Santa Rosa in early 2005 from aspiration pneumonia.

In 2004, considerable injuries resulted from pen-mate aggression, especially in the Santa Rosa facilities after release of captive animals to the wild. Some of the aggression is specific to individuals, whereas other case may have been misdirected aggression due to visits to the pen sites by released foxes. Much of the aggression-caused injuries ceased after construction of perimeter fences around the captive facilities.

One Santa Rosa island fox with a history of prolapse and *Spirocerca* infection was treated with Doramectin in 2004. All captive foxes were given annual vaccinations against canine distemper virus (CDV).

#### Other Management Actions Required

With environmental compliance and planning completed and funding secured, removal of feral pigs (*Sus scrofa*) from Santa Cruz Island began in early 2005 as a joint project funded by The Nature Conservancy and NPS and implemented by TNC via contract. Removal is estimated to take 2-4 years to complete, but the bulk of the 3,000 - 5,000 pigs may be removed within 1-2 years of program initiation.

The NPS is also cooperating with other agencies in a feasibility study to determine if bald eagles (*Haliaeetus leucocephalus*) can be restored to the northern Channel Islands. Monies from the settlement of the Montrose contaminant case are funding the 5-year program, in which up to 12 young bald eagles will be

released on Santa Cruz Island annually. By the end of 2004 approximately 25 bald eagles remained Santa Cruz Island from summer releases in 2002-2004.

#### Integrated Island Fox Recovery Team Meeting

From 1999 through 2003 the Island Fox Conservation Working Group, a loose affiliation of entities concerned with conservation of island foxes, met annually to consider conservation challenges faced by the species. After 4 island fox subspecies were listed as endangered in 2004, the U.S. Fish and Wildlife Service established an island fox recovery team that retained the characteristics of the Island Fox Conservation Working Group. The integrated island fox recovery team comprises all 70+ individuals from the former working group as well as other subject matter experts. Team members are self-assigned into specific technical expertise groups, from which individuals are chosen to work on task forces in response to requests from land management agencies (NPS, TNC, Santa Catalina Island Conservancy) regarding management and recovery of island foxes. The task requests are allocated to task groups by the island fox Recovery Coordination Group (RCG), which also receives the resulting analyses from the task groups and passes on recommendations to the land management agencies, via the Service.

The integrated island fox recovery team met in June 2004 to establish technical expertise groups and task forces, and begin addressing the task requests formulated by the land management agencies.

## Introduction

The island fox, a diminutive relative of the gray fox (*U. cinereoargenteus*), is endemic to the California Channel Islands. The fox exists as 6 different subspecies on each of the 6 islands, a distinction upheld by morphological and genetic work (Wayne et al. 1991, Collins 1993). The subspecies on the 3 northern Channel Islands are in genuine danger of extinction from unnatural levels of golden eagle predation and from extremely low population levels.

In 2004, the U.S. Fish and Wildlife Service listed as endangered 4 island fox subspecies, including the 3 subspecies in the Park (San Miguel Island fox [*U. l. littoralis*], Santa Rosa Island fox [*U. l. santarosae*], and Santa Cruz Island fox [*U. l. santacruzae*]) as well as the subspecies on Santa Catalina Island (*U. l. catalinae*).

Island fox populations were annually monitored on San Miguel Island from 1993 to 1999, and on Santa Cruz Island from 1993 to present. The island fox population on San Miguel declined beginning in 1994 with the adult population falling from 450 in 1994 to 15 in 1999 (Coonan et al. 2005). The Santa Cruz population declined from approximately 2,000 adults in 1994 to perhaps less than 135 in 2000 (Roemer 1999), and the current population is probably less than 100 adults (D. Garcelon, Institute for Wildlife Studies, unpubl. data). Survey data from Santa Rosa Island (G. Roemer, Institute for Wildlife Studies, unpublished data) indicate that island foxes experienced a similar catastrophic decline on that island as well. Foxes on Santa Rosa may have numbered more than 1,500 in 1994 (Roemer et al. 1994) but declined to 14 animals by 2000 (Coonan and Rutz 2001). Prior to implementation of island fox recovery efforts, Roemer (1999) estimated time to extinction at 5 years for island foxes on San Miguel and 12 years for island foxes on Santa Cruz.

Predation by golden eagles (*Aquila chrysaetos*) is the primary mortality factor now acting upon island foxes on the northern Channel Islands, and is likely responsible for the massive decline of the 3 northern subspecies from 1994 to 2000 (Roemer et al. 2001a). Evidence from several studies supports this. Golden eagle predation was identified as cause of death for 19 of 21 island fox carcasses found on Santa Cruz Island from 1993 to 1995 (Roemer et al. 2001a). On San Miguel Island in 1998-1999, 4 of 8 radiocollared island foxes were killed by golden eagles in a 4-month period, and another 2 died of unknown causes (Coonan et al. 2005). From January 2001 through April 2005, 32 of 36 mortalities of radiocollared foxes on Santa Cruz Island were due to golden

eagle predation (D. Garcelon, Institute for Wildlife Studies, unpubl. data).

The observed level of golden eagle predation is unnatural. Until recently, golden eagles never bred on the Channel Islands and their recent appearance is due to a prey base, feral pigs (*Sus scrofa*), that was not present prehistorically. The absence of bald eagles (*Haliaeetus leucocephalus*), which bred historically on the islands and whose presence may have kept golden eagles away, is another factor contributing to golden eagle predation. Moreover, on much of the northern Channel Islands, historic sheep grazing changed the predominant vegetation from shrub to non-native grasslands, which offer much less cover from aerial predators.

Upon receiving recommendations from a convened panel of experts, the Park began taking emergency recovery actions in 1999. In summer 1999, the Park constructed pens on San Miguel and began capture of wild island foxes. By January 2000, 14 island foxes had been captured and placed in the pens, leaving only 1 in the wild. Four of the captured foxes were males, and so were paired with 4 females for breeding. In 2004, after 5 years of breeding the San Miguel captive population had increased to 50 animals, exceeding the target captive population size of 40 animals and allowing initial releases back to the wild in fall 2004.

A captive breeding program was initiated for Santa Rosa Island in 2000. The initial captive population on Santa Rosa was 14 animals, which proved to be the island's remaining fox population. Some females were pregnant when captured, and 3 litters were born in captivity in 2000. With an increase to 56 foxes in 2003, the captive population on Santa Rosa exceeded the target captive population size of 40 foxes, and initial releases began in winter 2003/2004.

The status of eagles and foxes on Santa Cruz Island was assessed at the 2001 meeting of the Island Fox Conservation Working Group, with consensus being that captive breeding was warranted for that island fox population. In February 2002, a 10-pen captive breeding facility was built on Santa Cruz Island by the National Park Service and The Nature Conservancy. This facility was stocked with 12 adult island foxes caught in pairs or as individuals from separate areas of the island. The captive population increased to 30 foxes in 2003, and small releases were conducted in 2002 and 2003.

The Park established a cooperative agreement with the Santa Cruz Predatory Bird Research Group (SCPBRG) in 1999 for the purpose of relocating golden eagles from the northern Channel Islands. Personnel from the SCPBRG began eagle survey and removal on Santa

Cruz Island, the island with the most recent sightings, in late summer 1999. Golden eagles are now known to breed on both Santa Cruz and Santa Rosa Islands. By the end of 2004, 37 golden eagles had been removed from Santa Cruz Island, the majority by bownet trapping. Captured birds were released in northeastern California, and satellite telemetry indicates that none have attempted to return to the islands.

In 2003, the Park completed a recovery strategy for island foxes on the northern Channel Islands (Coonan 2003). The recovery strategy is in the format of a U.S. Fish and Wildlife Service recovery plan, identifying threats to the species, delineating goals, objectives and recovery criteria, and presenting a schedule and cost estimates for recovery actions. Appropriate recovery goals for each of the 3 island fox subspecies in the northern Channel Islands were determined via demographic modeling. Population viability analysis was used to identify target population levels which would minimize the chance of extinction. Modeling was then used to set an augmentation (captive breeding and release) schedule that would achieve those targeted goals in a reasonable timeframe.

The island fox recovery strategy calls for a continuation of the emergency actions of island fox captive breeding and golden eagle removal, as well as the separately funded actions of feral pig removal from Santa Cruz Island and reintroduction of bald eagles to the northern Channel Islands. Full recovery of island foxes on San Miguel and Santa Rosa Islands may take over a decade, although recovery on Santa Cruz Island may be achieved sooner.

Given the recent listing of the Park's three island fox subspecies as Endangered, it is likely that the Park's island fox recovery strategy will be superseded by an official recovery plan developed under the direction and authority of the U.S. Fish and Wildlife Service.

### ***2004 Meeting of the Integrated Island Fox Recovery Team***

From 1999-2003, the NPS convened a group of experts annually to help evaluate the status of island foxes on Park lands, and to make findings regarding appropriate recovery actions. The Island Fox Conservation Working Group, as it was called, comprised a loose affiliation of public agency representatives, landowners, conservancies, zoological institutions, non-profits and academics concerned about conservation efforts for the island fox.

The working group served as a forum for information exchange and evaluation of recovery efforts, dividing into subject matter

groups to tackle most issues. The group annually reported the status of island foxes on all islands and listed findings in regard to threats to the species and appropriate mitigation actions (see Appendix A in Coonan et al. 2004).

The U.S. Fish and Wildlife Service established an island fox recovery team that retained the characteristics of the Island Fox Conservation Working Group. Although many recovery teams comprise a small number of individual experts, the Service established an integrated island fox recovery team comprising all 70+ individuals from the former working group. The individuals are members of specific technical expertise groups, from which individuals are chosen to work on task forces in response to requests from land management agencies (NPS, TNC, Santa Catalina Conservancy) regarding management and recovery of island foxes. The task requests are allocated to task groups by the island fox recovery coordination group, which also receives the resulting analyses from the task groups and passes on recommendations to the land management agencies, via the Service.

The integrated island fox recovery group met in June 2004 to establish technical expertise groups and task forces, and begin addressing the task requests formulated by the land management agencies. Information on the integrated island fox recovery team is available from the Ventura Field Office of the U.S Fish and Wildlife Service.



*Captive island  
foxes, San  
Miguel Island*

## **Captive Breeding Program Development**

### ***The Need for Captive Breeding as a Recovery Action***

The Park's island fox recovery strategy (Coonan 2003) identifies captive breeding as a critical recovery element necessary to recover island fox populations to viable levels on the northern Channel Islands. Current island fox populations on San Miguel, Santa Rosa, and Santa Cruz Islands number 48, 56, and >140 foxes, respectively. The probability of extinction is high for these critically low populations (Roemer et al. 2001b) and the populations require augmentation to reach viable levels. Demographic modeling suggests that an appropriate augmentation schedule can return island foxes to viable population levels within a reasonable timeframe (a decade). The former Island Fox Conservation Working Group recommended captive breeding as a recovery action. Once golden eagles are removed from the northern Channel Islands, captive breeding will be the most important recovery action implemented for island foxes, and will require commitments of resources and personnel far exceeding any other recovery action. In this context we report on the status of the program after 5 years of breeding.

### ***Goals and Objectives for Captive Breeding***

The following goals and objectives for the island fox captive breeding program at Channel Islands National Park were developed upon consultation with the captive breeding sub-group of the Island Fox Conservation Working Group.

#### **Overall Goal**

To develop a captive breeding program for island foxes on San Miguel Island (*U. l. littoralis*), Santa Rosa Island (*U. l. santarosae*) and Santa Cruz Island (*U. l. santacruzae*) in order to increase their wild populations to viable levels.

#### **Overall Objective**

To design and implement captive breeding programs for the primary purpose of generating animals suitable for reintroduction into appropriate habitat, once the threats to the populations in those habitats have been minimized or eliminated.

## **Specific Objectives**

1. Define scope and duration of program; set facility size and configuration.
2. Construct and populate breeding facilities for the San Miguel, Santa Rosa and Santa Cruz Island fox populations.
3. Pair animals for breeding; monitor breeding behavior and results.
4. Develop appropriate release strategies.
5. Release foxes annually back into the wild; monitor wild foxes.

## **Program Guidance**

Guidance for the captive breeding program has been provided generally by the captive breeding and veterinary sub-groups of the Island Fox Conservation Working Group, and their findings and recommendations have been incorporated into the Park's captive breeding program (Coonan and Rutz 2001, 2002, 2003, Coonan et al. 2004). For guidance in design of captive enclosures and development of husbandry protocols, we consulted the American Zoological Associations' management recommendations for small canids in captivity, as well as the American Society of Mammalogists' guidelines for the capture, handling and care of mammals (American Society of Mammalogists 1987). Moreover, the Santa Barbara Zoo has organized two island fox husbandry workshops and has produced island fox husbandry guidelines incorporating recent experience in island fox husbandry.

## **Standard Operating Procedures**

The following standard operating procedures have been developed for the captive breeding program:

## **Facility Design and Construction**

- In order to minimize the chance of disease, parasites or other catastrophe causing extirpation of captive populations, San Miguel and Santa Rosa Islands each have two separate breeding facilities.
- Staff level must be adequate for caretaking 40-50 animals at two sites.
- Sufficient distance is maintained between pens, while within the pens hiding places are provided; thus animals have visual contact with others when they choose.
- Annual pen construction is completed by October to allow pairs sufficient time to bond prior to breeding.



- There should be a minimum of two isolation areas at each facility.
- The threat of wildfire at captive breeding facilities is addressed by the Park's fire management program, and Vari-Kennels are available for immediate evacuation of foxes.
- Perimeter or electric fences are required at most facilities to prevent contact between captive and wild foxes. Aggressive encounters through the pen walls have been a source of injuries to both captive and wild foxes.

### **Veterinary Care**

- If foxes are brought to the mainland for veterinary care, they cannot be returned to the islands, because of possible disease/parasite transmission.
- Captive foxes are given annual veterinary examinations, using a standardized veterinary protocol.
- Each captive breeding population has access to a veterinary/quarantine facility where animals may be treated.
- Protocols are implemented to minimize the risk of people or equipment transferring pathogens among islands, and to minimize parasite loads in the captive populations.
- Captive foxes are vaccinated annually against canine distemper virus, using a recently developed Canary pox vectored recombinant vaccine (Purevax Ferret Distemper vaccine, Merial Ltd., Athens, GA).

### **Caretaking and Handling**

- Human contact with captive foxes is minimized to avoid acclimating them to humans, and to ensure they are as wild as possible upon release.
- Handling and disturbance of captive island foxes is avoided during the full extent of the breeding season (January through June).

### **Breeding Strategy**

- Mated pairs are kept together as long as they reproduce successfully; non-reproductive pairs are kept together for at least two breeding seasons.
- Pairings of siblings or parent/offspring are avoided using genotyping of individual animals, and estimation of relatedness.

- Video monitoring is used to the extent practicable to document breeding behavior or lack thereof, and to record birth dates, pup fate, and neonatal care.
- Captive-born foxes are preferentially paired with wild-born individuals, provided existing pairs are not broken up, to minimize loss of wild behavioral traits.
- Birth, death and breeding records are maintained in a studbook. Annual analysis by staff from the AZA's Population Management Center is used to choose new pairings of captive animals as well as to identify genetically appropriate candidates for release to the wild.
- Excess females may be housed together if compatible to allow for social interaction or to possibly test reproductive potential of one male with two females. However, no more than two females should be housed together in one pen.

## **Diet**

- In 2004 captive foxes were fed a high-quality dry dog (24% crude protein, 14% crude fat) supplemented with hard-boiled eggs, and a variety of fruits and vegetables. This is supplemented several times per week by live deer mice or dead coturnix quail. To address recurring problems of weight gain in captive foxes, in December 2004, upon the advice of project veterinarians, we switched the dry kibble brand from Innova® Dog Food™ (Natura Pet Products, Santa Clara, CA) to Science Diet (Hills Pet Products, Topeka, KS). Science Diet has less crude protein (21.5%) and crude fat (13.0%).
- Captive foxes are not given moist meat-based food, such as canned cat or dog food, or fruits high in citric acid, since they may cause gingivitis and tooth loss.
- The amount of food given daily is on average 3-4% dry weight of the foxes' body weight (i.e., a 2.3 kg adult receives 60-70 g of dry kibble, plus supplements, daily).
- During breeding season, females suspected to be pregnant or with litters were fed dog kibble with higher crude protein (26%) and more essential fatty acids (Innova® Puppy Food™, Natura Pet Products, Santa Clara, CA). Family groups are fed this diet until the pups reach adult body size (October). After December 2004, the breeding season diet will include Science Diet Growth Formula (25.5% crude protein, 16.5% crude fat) rather than Innova Pup.

## Overall Breeding Success

In 2004, the San Miguel captive population increased from 38 to 50 individuals, with 12 pups born to 4 litters. On Santa Rosa the captive population increased to 54 individuals with 9 pups born to 4 litters, and the deaths of 2 foxes in captivity. On Santa Cruz the captive population increased to 42 individuals with the addition of 19 pups born to 8 litters, and the escape of 2 foxes from captivity.

Sixteen of 44 paired females produced litters in 2004 (36%) compared to 14 of 38 in 2003 (37%), 9 of 21 in 2002 (43%) and 7 of 13 in 2001 (54%). The percentage of successfully breeding females is less in recent years primarily because more captive-born females have been paired, and captive-born females have largely failed to breed. Of 18 captive-born females paired in 2004, only 1 (6%) produced a litter. In comparison, 15 of 26 wild-born females (58%) produced litters in 2004. Overall, only 2 of 26 pairs involving captive-born females have bred, whereas 21 of 35 pairs involving wild-born females (60%) have been successful.

One might expect the breeding success of captive-born females to increase with age, because female age is a factor in reproduction among wild foxes. Only 19% of Age Class I (1-2 year old) females produced in the wild, compared to older females (Coonan et al. 2005). However, of 12 captive pairings involving captive-born females aged 3 or 4 years, all have failed (Table 1).

**Table 1. Breeding success of captive-born females, by age.**

Age (Years)	Litters	Failures
1	0	10
2	2	12
3	0	8
4	0	4

The breeding success of captive-born males is also less than that of wild-born males. Eight of 31 pairs with captive-born males have produced litters, for a success rate of 25%. In contrast, 13 of 18 pairs with wild-born males (72%) have produced litters. However, a better test of captive-male reproductive success would consider male success only when paired with wild-born females, since captive-born female breeding success is so low. Excluding captive-born females from the analysis, captive-born males have a success rate of 46% (18 litters out of 39 pairings), and wild-born males have a success rate of 60% (33 litters out of 55 pairings).

No additional founders were added to the San Miguel population in 2004, and to date only 5 out of 10 potential female founders on San Miguel have bred. Thus the number of founders remains low on San Miguel (7; see Appendix B). This is partly due to the low number of males (4) brought into captivity in 1999.

On Santa Rosa, 12 of 14 potential founders have bred. The 12<sup>th</sup> founder was added in 2004 when a wild-born female (33131) which had failed to breed in captivity was released to the wild and subsequently produced a litter of 2 female pups in the wild.

Overall, reproductive output in captivity is similar to that observed in the wild. The average number of pups weaned in captive litters (2.4, n = 51 litters) is slightly higher than the average number of pups weaned in the wild on San Miguel from 1993 to 1998 (2.0, n = 34) (Coonan et al. 2004).

The proportion of females that has produced litters in captivity is also similar to that observed in the wild. In captivity, 47 of 119 annual pairings (39.5%) have produced litters (Table 3), compared to 42.8% in the wild (54/126 pairings; Coonan et al. 2004). The proportion of females breeding is twice as high on Santa Cruz as on San Miguel or Santa Rosa (Table 3), perhaps because most of the pairs on Santa Cruz have involved wild-born females.

Mate history also affected likelihood of breeding. Most captive fox pairs were not successful in their first year of mating. Restricting the analysis to wild-born female foxes, only 42.4% of 33 first-year matings were successful, whereas 60.0% of 54 second and third-year matings were successful.

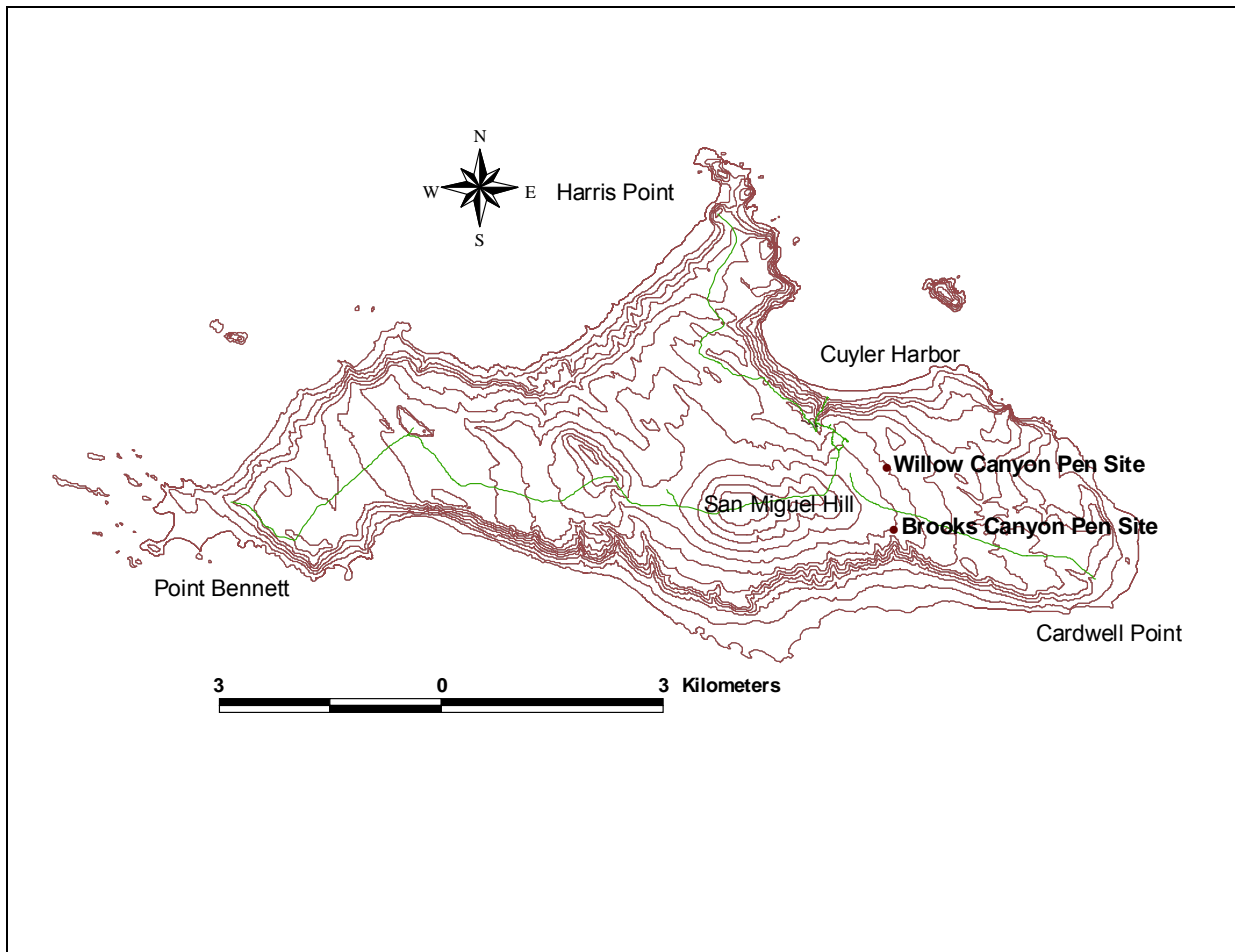
**Table 2. Average number of pups weaned per litter, 1999-2004.**

Island	Avg. No. of Pups Weaned	n
San Miguel	2.5	15
Santa Rosa	2.4	22
Santa Cruz	2.3	14

**Table 3. Proportion of annual pairings that produced litters, 1999-2004.**

Island	Litter	No Litter	Total	% Success
San Miguel	15	31	46	32.6
Santa Rosa	19	34	53	35.8
Santa Cruz	13	7	20	65.0
Total	47	72	119	39.5

In summary, reproductive success for captive foxes has been similar to that of wild foxes on San Miguel from 1993-1998. Age Class I females rarely bred, and the average number of pups weaned was similar for captive and wild foxes. First-year matings were less successful than mating. The primary determinant of breeding success at this juncture appears to be whether females are wild-born or captive born. In captivity there has been a general failure of captive-born females to breed, though many of these matings were of first-year animals.



**Figure 1. Location of island fox captive breeding facilities, San Miguel Island.**

## Recovery of San Miguel Island Foxes

With the birth of 12 pups in spring 2004, the captive island fox population on San Miguel Island grew to 50 foxes, of which 10 were released to the wild in fall 2004 (Tables 4-8). Two foxes died in captivity in April 2005, and none had died after being released to the wild, as of 30 June 2005, leaving 10 in the wild and 38 in captivity.

### Captive Breeding

Four of 15 pairs (27%) produced litters in 2004. Of the 12 pups born in captivity in 2004, 8 were female, which brought the overall sex ratio more toward parity (27M:23F). One pair (pen M11) had a litter of 5 pups, which is only the second litter of 5 to be born in the captive program. No new founders bred in 2004, and the number of founders for the San Miguel population remained at 7. Six captive-born and 5 wild-born females failed to produce litters in 2004.

**Table 4. Growth of captive island fox population, San Miguel Island.**

Year	Adults			Pups			Died	Released	Total Captive
	F	M	Total	F	M	Total			
2000	10	4	14 <sup>1</sup>	1	1	2	0		16
2001	11	5	16	0	5	5	1		20
2002	10	10	20	2	6	8	0		28
2003	13 <sup>2</sup>	16	29	3	7	10	1		38
2004/05	15	23	38	8	4	12	2	10	38

<sup>1</sup>Founding population

<sup>2</sup>Includes the last wild fox, female 33053, brought into captivity in September 2003; died in December 2003

**Table 5. Reproductive success of captive San Miguel Island foxes, 2003-2004 breeding season.**

Pen	PitTag	Sex	Age	Paired	Result	Litter Size	Birth Date
M01	87F53	M	2				
	85764	F	2	11/2/2002	No Litter		
M02	B0E36	M	2				
	33053	F	7	9/29/2003	*		
M03	7574A	M	6				
	92C32	F	6	7/16/1999	Litter	1	≈April 10, 2004
M07	44829	M	6				

Pen	PitTag	Sex	Age	Paired	Result	Litter Size	Birth Date
	90D1A	F	6	9/4/1999	Litter	3	≈April 10, 2004
M08	C111F	M	1				
	53A78	F	1	11/15/2003	No Litter		
M09	70C1D	M	3				
	7534A	F	11	10/17/2001	No Litter		
M11	47B06	M	4				
	E2677	F	6	10/17/2000	Litter	5	≈April 1, 2004
M12	91167	M	1				
	B0B25	F	5	11/15/2003	No Litter		
M13	11F73	M	3				
	F6558	F	5	10/17/2002	No Litter		
M14	57150	M	6				
	60921	F	6	10/27/2002	No Litter		
M15	E666D	M	1				
	B7E0A	F	2	11/15/2003	No Litter		
M16	83C24	M	3				
	90C7D	F	1	11/15/2003	No Litter		
M17	C7303	M	3				
	11929	F	4	10/17/2001	No Litter		
M18	C4A16	M	3				
	71071	F	5	10/17/2001	Litter	3	≈April 3, 2004
M19	85D02	M	5				
	92804	F	12	10/27/2002	No Litter		
M22	5797C	M	1				
	03A13	F	1	11/15/2003	No Litter		

\*Female 33053 was brought into captivity 09/29/2003, and died from penmate aggression on 12/31/2003

According to the recommendations of the AZA's population management plan for island foxes (Lynch 2004), new pairings were implemented for San Miguel island foxes in October 2004. Six existing pairs were broken up, and 6 new pairs were created.

## Perimeter Fencing

The considerable injuries sustained by both wild and captive foxes on Santa Rosa Island in 2004 after the initial release of foxes to the wild underscored the need to effectively separate captive foxes from wild foxes on the northern Channel Islands. Accordingly, a perimeter fence was built around the Willow Canyon captive breeding facility in fall/winter 2004/2005. The fence is 6 ft high with a groundskirt and a 1.5 ft top panel canted outward at a 45 angle. Thus far, wild foxes have not breached the fence.

Pens at the Brooks Canyon site are spaced sufficiently distant from one another to make a perimeter fence impractical. Instead, individual electric fences have been constructed around each pen. Injuries to foxes in captivity ceased upon installation of the fences.

**Table 6. Island fox pups born in captivity, San Miguel Island, 2004.**

<b>PitTag</b>	<b>Studbook Number</b>	<b>Sex</b>	<b>Pen</b>	<b>Sire</b>	<b>Dam</b>
93901	229	M	M03	7574A	92C32
D1531	232	M	M07	44829	90D1A
C5D00	231	F	M07	44829	90D1A
11F6C	230	F	M07	44829	90D1A
E4B2D	237	M	M11	47B06	E2677
23B15	236	F	M11	47B06	E2677
06E4A	235	F	M11	47B06	E2677
D7074	234	F	M11	47B06	E2677
E770A	233	F	M11	47B06	E2677
71C3B	228	F	M18	C4A16	71071
52249	227	F	M18	C4A16	71071
63E0F	226	M	M18	C4A16	71071

## Health/Medical

All captive San Miguel island foxes were given annual veterinary examinations by Dr. Mark Willett, D.V.M., in September 2004 (Table 7). At time of examination, blood samples were taken from all animals and processed by IDEXX Laboratories (Sacramento, California) for hematology and complete blood chemistry. Injuries and other conditions requiring veterinary treatment are summarized in Appendix A. All captive foxes were vaccinated against canine distemper virus with a Canary pox vectored recombinant vaccine (Purevax Ferret Distemper vaccine, Merial, Inc., Athens, GA). Island foxes are normally vaccinated during annual veterinary examinations. Due to a nationwide shortage of the vaccine, island foxes were vaccinated in December 2004.

**Table 7. Veterinary examination dates, weights, and blood sample status for captive island foxes, San Miguel Island.**

<b>Fox ID</b>	<b>Sex</b>	<b>Age</b>	<b>Veterinary Exam Date</b>	<b>Weight (kg)</b>	<b>Blood Sample Taken</b>
B0B25	F	5	09/12/04	2.6	yes
B0E36	M	2	09/07/04	3.1	yes



Fox ID	Sex	Age	Veterinary Exam Date	Weight (kg)	Blood Sample Taken
B4E60	M	2	09/10/04	2.9	yes
B7E0A	F	2	09/12/04	2.65	yes
C111F	M	1	09/09/04	2.75	yes
C311C	M	1	09/08/04	3.05	yes
C4A16	M	3	09/11/04	3.3	yes
C5D00	F	juvenile	09/09/04	2.3	yes
C7303	M	3	09/11/04	2.9	yes
D1531	M	juvenile	09/09/04	2.95	yes
D7074	F	juvenile	09/09/04	2.2	yes
E2677	F	6	09/09/04	3.45	yes
E4B2D	M	juvenile	09/09/04	2.3	yes
E270B	M	2	09/10/04	3.1	yes
E666D	M	1	09/12/04	2.7	yes
E770A	F	juvenile	09/09/04	2.4	yes
F6558	F	5	09/12/04	2.75	yes
03A13	F	1	09/10/04	2.5	yes
06E4A	F	juvenile	09/09/04	2.45	yes
11F6C	F	juvenile	09/09/04	2.3	yes
11F73	M	3	09/12/04	3.7	yes
11929	F	4	09/11/04	2.6	yes
13212	M	2	09/10/04	3.1	yes
23B15	F	juvenile	09/09/04	2.3	yes
44829	M	6	09/09/04	3.7	yes
47B06	M	4	09/09/04	3.55	yes
52F0C	M	1	09/08/04	2.75	yes
52249	F	juvenile	09/11/04	2.6	yes
53A78	F	1	09/09/04	2.8	yes
57150	M	6	09/12/04	3.1	yes
5797C	M	1	09/10/04	2.4	yes
60921	F	6	09/12/04	2.85	yes
63E0F	M	juvenile	09/11/04	2.4	yes
66C6E	M	2	09/10/04	3.15	yes
70C1D	M	3	09/07/04	3.3	yes
71C3B	F	juvenile	09/11/04	2.2	yes
71071	F	5	09/11/04	2.3	yes
7534A	F	11	09/07/04	3.3	yes
7574A	M	6	09/08/04	3.4	yes
83C24	M	3	09/11/04	3.25	yes
84E33	M	1	09/10/04	3.2	yes
85D02	M	5	09/10/04	3.4	yes
85764	F	2	09/08/04	2.85	yes
87F53	M	2	09/08/04	3.2	yes
90C7D	F	1	09/11/04	2.5	yes
90D1A	F	6	09/09/04	2.6	yes
91167	M	1	09/12/04	2.65	yes
92C32	F	6	09/08/04	4.1	yes

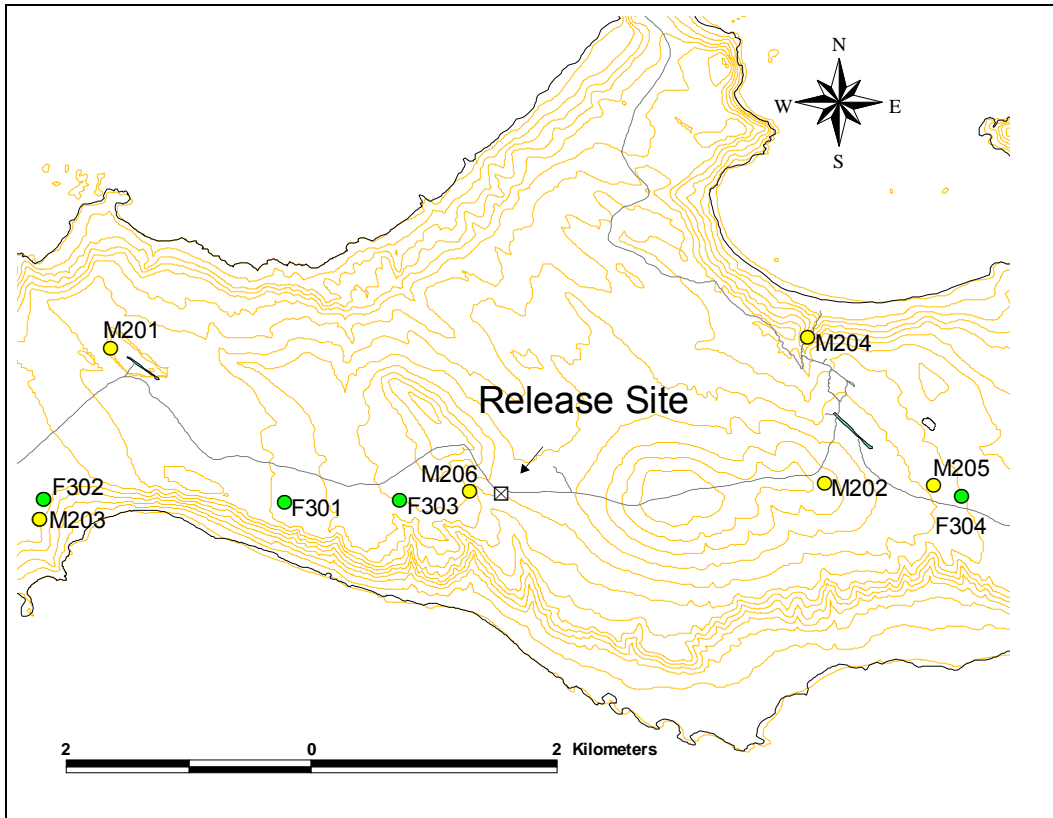
Fox ID	Sex	Age	Veterinary Exam Date	Weight (kg)	Blood Sample Taken
92804	F	12	09/10/04	3.2	yes
93901	M	juvenile	09/08/04	2.6	yes

**Table 8. Island fox mortalities, San Miguel Island, 2004-2005.**

PIT tag	Release ID	Sex	Age	Date	Specimen Depository <sup>1</sup>	Area	Mortality Cause
60921	--	F	7	04/09/2005	UCD	In captivity	Septicemia subsequent to mastitis
11F6C	--	F	1	04/28/2005	UCD	In captivity	Septicemia subsequent to mastitis

<sup>1</sup>UCD = UC Davis Veterinary Medical Teaching Hospital

Two non-neonatal mortalities occurred among captive island foxes on San Miguel in 2004-2005 (Table 8). Both females, each of which had just given birth, died of septicemia (bacterial infection) and showed evidence of mastitis (inflammation of the mammaryes) (L. Munson, UC Davis, pers. comm.) Female 60921, a wild-born fox estimated to be at least 7 years old, died on April 9, 2005, shortly after giving birth to 2 pups, which did not survive. Preliminary necropsy results indicate that, in addition to septicemia and mastitis, dystocia (difficult birth) was likely caused by a large colonic mass located near the pelvis, itself likely the result of *Spirocerca* infection (L. Munson, UC Davis, unpubl. data). Female 60921 tested positive for *Spirocerca* during parasite assays in 2001 and 2004. In island foxes *Spirocerca* can cause colonic granulomas which can result in prolapse, septicemia and other problems, and many San Miguel pens have tested positive for the parasite. In 2004, 60921, a potential founder that never bred in captivity, also gave birth to 2 pups which did not survive.



**Figure 2. Recent locations, as determined by radiotelemetry, of island foxes released to the wild on San Miguel Island.**

The second mortality also occurred in April, 2005. Female 11F6C, born in April 2004, died on April 28, 2005, 3 days after giving birth to 3 pups, none of which survived. Just prior to her death 11F6C was emaciated (her weight was 1.7 kg), hypothermic and non-ambulatory. Cause of death was determined to be septicemia, secondary to mastitis (L. Munson, UC Davis, pers. comm.).

During 2004, captive island foxes on San Miguel remained remarkably injury-free until November (Table 8), after foxes had been released to the wild. Many of the injuries that subsequently occurred may have been caused by the presence of wild island foxes near the pens. Some injuries may have been specifically caused by foxes fighting through the pen walls, while others may have been misdirected aggression between pen-mates, caused by wild fox presence. Most injuries occurred at the Brooks Canyon breeding sites, which was not protected by fencing until spring 2005; the Willow Canyon site was fenced by November 2004. Three female foxes sustained injuries during the breeding season, likely due to aggression by males with which they have been paired. Those injuries ceased upon construction of fencing to separate wild and captive foxes.

**Table 9. Injuries to captive San Miguel island foxes, 2004-2005.**

Date	Fox ID	Sex	Pen	Injury	Treatment
11/1/2004	92804	F	M19	Ear swollen and abscessed, likely due to mate aggression, new mate 13212 had been introduced 10/16	Antibiotic; offending male reassigned
12/12/2004	C7303	M	M17	Split pad and digits	Pad was stapled, antibiotics administered
12/12/2004	57150	M	M14	Injuries on all 4 paws.	Topical treatment, released back to pen
12/12/2004	85D02	M	M16	Minor foot injuries	Topical treatment, released back to pen
12/18/2004	C111F	M	M20	Tear between digits	Bandage
1/13/2005	7534A	F	M09	Bite wound, torn tendon, necrotized	Wound sutured, antibiotics
1/26/2005	66C6E	M	M19	Pad wound	Suture and drain; released into pen on 03/09/2005
1/28/2005	57150	M	M14	Pad wound	Suture, in foxpital until 02/07/2005, released back into M14
1/30/2005	B0B25	F	M12	Ear injury	Antibiotics, released into pen
2/7/2005	92804	F	M19	Cut on forepaw, likely from fighting through pen wall, because mate (66C6E) was in foxpital at the time	Wound glued, released back into pen on 03/11/2005

### ***Reintroduction of San Miguel Island Foxes***

Ten foxes (4 female, 6 male) were released to the wild between 28 October and 07 November, 2004, at a release site southeast of Green Mountain. The released foxes were individuals identified as appropriate release candidates by Lynch (2004). The 4 females were juvenile littermates from the 2004 litter of 5 pups in pen M11. The 6 males ranged in age from juvenile (born in 2004) to 3 yrs, and were all offspring of the pair in M7.

**Table 10. Release location, date, release type and fate of foxes released to the wild on San Miguel Island, fall 2004.**

PIT tag	ID	Sex	Age	Date	Release Type <sup>1</sup>	Area	Fate
83C24	201	M	3	10/28/2004	P	Green Mountain	In wild
E770A	301	F	0.5	10/28/2004	P	Green Mountain	In wild
E270B	202	M	2	10/29/2004	Gr	Green Mountain	In wild
B4E60	203	M	2	10/29/2004	Gr	Green Mountain	In wild
70C1D	204	M	3	10/30/2004	P	Green Mountain	In wild
D7074	302	F	0.5	10/30/2004	P	Green Mountain	In wild
D1531	205	M	0.5	11/06/2004	P	Green Mountain	In wild
23B15	303	F	0.5	11/06/2004	P	Green Mountain	In wild
84E33	206	M	1	11/07/2004	P	Green Mountain	In wild
06E4A	304	F	0.5	11/07/2004	P	Green Mountain	In wild

<sup>1</sup>P = mated pair  
 Gr = Group  
 S = single animal

As of 15 June 2005, all 10 released foxes were alive, with functioning radiocollars (Table 10, Fig. 4). Foxes generally remained at the release site for about a week after release. Several foxes are still in the general area of the release site. Others have dispersed east and west of the release site. No foxes were returned to captivity because of unacceptable weight loss after release. One male fox, M204, was returned to captivity for 4 days (November 25–29) due to open wounds he received, cause unknown. After 4 days of treatment with antibiotics he was re-released to the wild.

Several foxes have been recorded near the captive facilities, and one injury to a captive fox may be the result of a reaction to wild foxes. Four males have been consistently recorded near individual females, suggesting that pair formation may be occurring. However, because each of the females is a juvenile, the chance of each producing a litter in spring 2005 is slim.

Foxes were released as pairs or as same-sex groups. Prior to release, foxes slated for release either as pairs or groups were

housed in captivity with their release-mates for a period of 7-14 days. Of four pairs released in this manner on San Miguel (Table 9), members of 1 pair (M201-F301) were still located near each other and may be forming a pair bond.

Four feeding stations were established in the general area of the release. Supplemental feeding was conducted at the stations for a period of 6 weeks following the initial release on 28 October, 2004. Stations were provisioned with 120-150 g of dry dog kibble. Stations were re-provisioned twice a week for the first 4 weeks, and then once a week for the final two weeks. With the exception of the first week following the initial release, all feeding stations were empty when visited for re-provisioning.

All island foxes were released at weights that were higher than average weights of wild foxes. Average release weight for the 4 females was 2.35 kg, and average release weight for the 6 males was 2.93 kg (Table 11). As expected, all foxes lost weight in the weeks following release and appeared to stabilize at weights above average summer wild adult weights of males (2.25 kg) and females (2.06 kg) (Coonan et al. 1998).

Preliminary results from remote camera and direct observations indicate that at least 6 wild pups were born on San Miguel Island in spring 2005. Released females F304, F303, and F301 all produced litters, and there remains a possibility that the remaining female, F302, produced a litter as well.

The significant and surprising reproductive success among the released females is noteworthy. All 4 released females were juveniles (born in 2004) and juvenile females have not produced well in captivity, nor do wild juveniles typically reproduce at a high rate (Coonan et al. 2005). Low wild fox density and the resulting lack of competition for territories and food may explain the high reproductive success among the females released from captivity. Coupled with the currently mediocre reproductive success among females in captivity, the utility of a wild population becomes apparent. Accordingly, larger releases to the wild may be appropriate.

### ***Future Management of San Miguel Island Foxes***

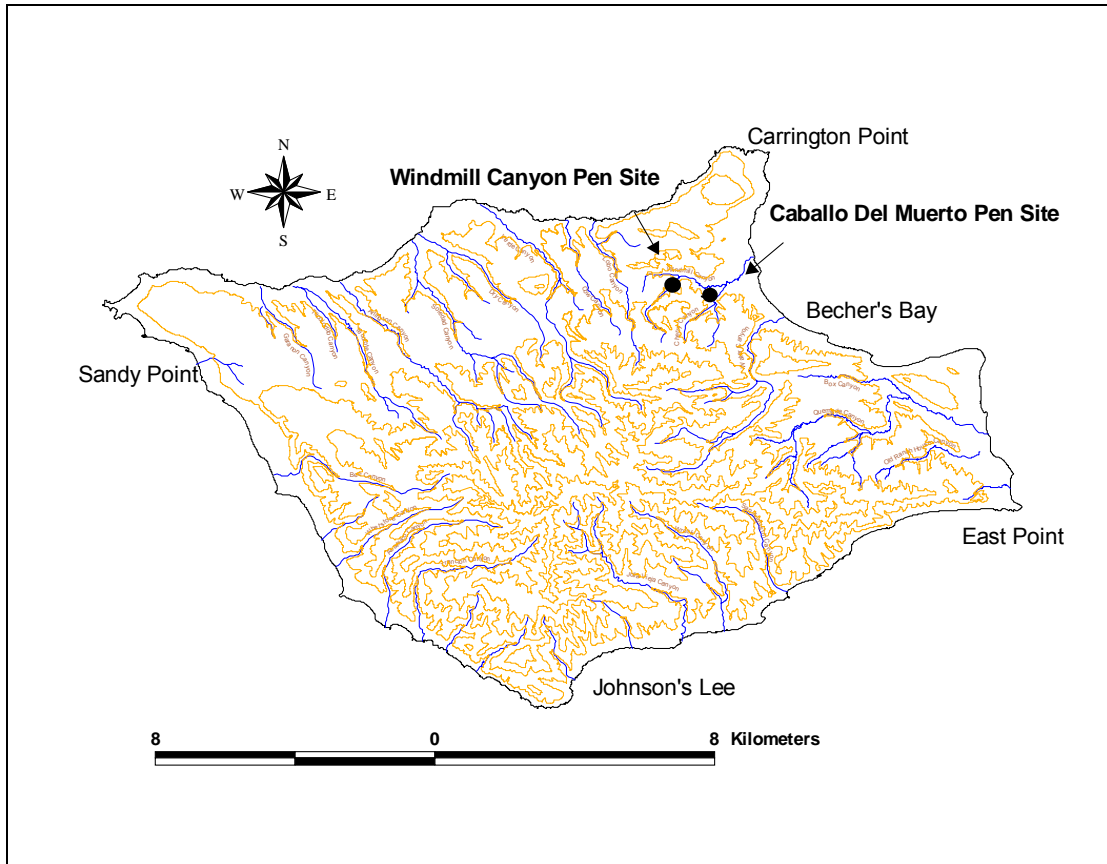
Ten to 25 additional island foxes will be released in fall 2005, the final number dependent upon recommendations from the island fox Recovery Coordination Group. Captive and wild pups born in 2005 will be PIT-tagged. All captive foxes will be given veterinary examinations, will have blood samples drawn for testing, will be vaccinated against canine distemper virus and rabies, and will be given veterinary treatment as required for

injuries and other medical conditions. Foxes will be released to the wild under an annual release plan developed in summer 2005.

It is estimated that captive breeding and annual releases will continue for approximately 10 years, until San Miguel Island foxes have reached a target population size (Coonan 2003) which insures the likelihood of persistence.

**Table 11. Capture dates and weights for island foxes released to the wild, 2004, San Miguel Island.**

Fox ID	Date	Weight	Comments
F301	10/28/2004	2.45	release
	11/5/2004	2.30	
	11/15/2004	2.20	
F302	10/30/2004	2.00	release
	11/6/2004	2.10	
	11/13/2004	1.95	
F303	11/6/2004	2.45	release
F304	11/7/2004	2.50	release
	12/19/2004	2.25	
M201	10/28/2004	2.90	release
	11/5/2004	2.20	
	11/13/2004	2.40	
M202	10/29/2004	3.20	release
	11/13/2004	2.90	
M203	10/29/2005	2.80	release
	11/5/2004	2.45	
	11/15/2004	2.40	
M204	10/30/2004	2.90	release
	11/5/2004	2.60	
	11/25/2004	2.40	Brought into captivity due to wounds received; re-released on 11/29
M205	11/7/2004	2.90	release
	11/14/2004	2.85	
	12/12/2004	2.60	
M206	11/7/2004	2.90	release



**Figure 3. Location of island fox captive breeding facilities, Santa Rosa Island.**

## Recovery of Santa Rosa Island Foxes

The captive island fox population on Santa Rosa Island grew to 54 foxes in spring 2004 with the addition of 9 pups (Tables 12-15), and the death of 2 foxes in captivity (Table 16). At the end of spring 2004 there were 8 foxes in the wild on Santa Rosa: 6 from the releases in fall 2003 – winter 2004, and 2 female pups born in the wild to Male 03 and Female 106. One of those wild female pups was brought into captivity in summer 2004, because her dam is a new founder for the Santa Rosa population. Thirteen captive foxes were released to the wild in fall 2004. As of May 15, 2005, 5 foxes released in fall 2004 had died from eagle predation, and 1 fox from the previous year's release (Male 03) had died when he became stuck in a vertical PVC sprinkler pipe near one of the ranch houses in the Becher's Bay area. As of May 15, 2005, there were 14 foxes in the wild, and 42 in captivity.



**Table 12. Growth of captive island fox population, Santa Rosa Island.**

Year	Adults			Pups			Died	Released	Total Captive
	F	M	Total	F	M	Total			
2000	8	4	12 <sup>1</sup>	5 <sup>2</sup>	5 <sup>2</sup>	10	0		22
2001	14 <sup>3</sup>	9	23	7	3	10	1		32
2002	20	12	32	9	4	13	0		45
2003	29	16	45	6	5	11	0	7	49
2004	30	19	49	2	7	9	2	13	43 <sup>4</sup>

<sup>1</sup>Founding population

<sup>2</sup>Includes 8 pups born in captivity, and 2 pups (1 male, 1 female) born in the wild

<sup>3</sup>An additional female was brought in from the wild on 05/14/2001

<sup>4</sup>Includes 1 female pup born in the wild in spring 2004 and brought into captivity

### ***Captive Breeding***

Four of 15 (27%) pairs produced litters in 2004. Of the 9 pups born in captivity in 2004, 7 were male, and the current sex ratio in captivity is 20M:24F. No new founders bred in captivity in 2004, though a potential founder released to the wild (Female 106) the previous year had a wild litter in 2004. Currently 12 of 14 potential founders for the Santa Rosa population have bred. Nine captive-born and 5 wild-born females failed to produce litters on Santa Rosa in 2004.

New pairings were implemented for Santa Rosa island foxes in October 2004, according to the recommendations of the AZA's population management plan for island foxes (Lynch 2004). Six existing pairs were broken up, and 9 new pairs were created.

**Table 13. Reproductive success of captive Santa Rosa Island foxes, 2003-2004 breeding season.**

Pen	PitTag	Sex	Age	Paired	Result	Litter Size	Birth Date
R01	60D24	M	1				
	2571A	F	2	11/15/2003	No Litter		
R02	0654E	M	4				
	D187A	F	6	10/19/2000	No Litter		
R03	0507B	M	1				
	2410E	F	4	11/15/2003	No Litter		
R04	53723	M	2				
	60B1D	F	3	10/24/2002	No Litter		
R05	F0223	M	6				
	F4A18	F	5	10/19/2000	Litter	3	unknown

Pen	PitTag	Sex	Age	Paired	Result	Litter Size	Birth Date
R06	F3D2F	M	3				
	37C61	F	4	11/15/2003	No Litter		
R07	70518	M	4				
	10030	F	6	10/19/2000	Litter	3	4/3/2004
R08	75125	M	3				
	95906	F	2	2/8/2004	No Litter		
R09	84F28	M	4				
	95B34	F	5	10/19/2000	Litter	1	4/10/2004
R10	B067E	M	6				
	47304	F	2	1/30/2004	Litter	2	unknown
R11	73D0D	M	5				
	3512D	F	6	11/5/2000	No Litter		
R12	51E3E	M	2				
	07061	F	6	10/24/2002	No Litter		
R13	37E00	M	4				
	96C2E	F	3	11/15/2003	No Litter		
R14	47E09	M	1				
	E5100	F	4	11/15/2003	No Litter		
R16	C4F63	M	1				
	E3F0F	F	2	11/15/2003	No Litter		
R18	7792E	M	2				
	F3950	F	3	10/24/2002	No Litter		
R19	D3D76	M	5				
	1612C	F	5	10/17/2001	No Litter		
R20	1271E	M	2				
	A180A	F	4	10/24/2002	No Litter		

Table 14. Island fox pups born in captivity, Santa Rosa Island, 2004.

Studbook					
PitTag	Number	Sex	Pen	Sire	Dam
A3B6D	223	F	R05	F0223	F4A18
B7A6D	221	M	R05	F0223	F4A18
80C3F	222	M	R05	F0223	F4A18
31049	218	F	R07	70518	10030
7305C	217	M	R07	70518	10030
03332	216	M	R07	70518	10330
85420	224	M	R09	84F28	95B34
7235F	219	M	R10	B067E	47304
9230A	220	M	R10	B067E	47304

### Perimeter Fencing

The considerable injuries sustained by both wild and captive foxes on Santa Rosa Island in 2004 after the initial release of

foxes to the wild underscored the need to effectively separate captive foxes from wild foxes on the northern Channel Islands. Accordingly, perimeter fences were built around the Windmill Canyon and Caballo del Muerto captive breeding facilities in 2004. The fence is 9 ft high (to exclude, or at least discourage, deer and elk) with a groundskirt. A portion of the fence has a 1.5 ft top panel canted outward at a 45 angle.

**Table 15. Veterinary examination dates, weights, and blood sample status for captive island foxes, Santa Rosa Island.**

Fox ID	Sex	Age	Veterinary Exam Date	Weight (Kg)	Blood Sample Taken
A180A	F	4	06/17/04	2.35	yes
A3B6D	F	juvenile	06/18/04	1.3	yes
A5E60	F	juvenile	07/13/04	1.0	yes
A7954	F	1	06/18/04	2.15	yes
B067E	M	6	06/19/04	3.05	yes
B4B2B	M	3	06/18/04	3.1	yes
B7A6D	M	juvenile	06/18/04	1.3	yes
B7D38	F	1	06/18/04	2.2	yes
C4F63	M	1	06/17/04	2.2	yes
C586D	F	3	06/18/04	2.25	yes
C7B1B	F	1	06/17/04	2.4	yes
D187A	F	6	06/19/04	2.15	yes
D4C78	M	1	06/16/04	2.8	yes
E3F0F	F	2	06/17/04	2.65	yes
E5100	F	4	06/17/04	2.65	yes
E6D1E	F	3	06/18/04	2.45	yes
F0223	M	6	06/18/04	2.7	yes
F3D2F	M	3	06/17/04	2.5	yes
F3950	F	3	06/17/04	3.4	yes
F4A18	F	5	06/18/04	2.3	yes
03332	M	juvenile	06/18/04	1.3	yes
0507B	M	1	06/18/04	2.5	yes
0654E	M	4	06/16/04	2.7	yes
07061	F	6	06/18/04	2.35	yes
10030	F	6	06/18/04	2.8	yes
10445	F	3	06/18/04	2.35	yes
1271E	M	2	06/17/04	2.7	yes
1612C	F	5	06/16/04	2.35	yes
2410E	F	4	06/18/04	3.8	yes
25D54	F	2	06/18/04	2.6	yes
2571A	F	2	06/16/04	2.45	yes
31049	F	juvenile	06/18/04	1.45	yes
3512D	F	6	06/17/04	2.25	yes
37C61	F	4	06/17/04	2.4	yes
37E00	M	4	06/17/04	2.25	yes

Fox ID	Sex	Age	Veterinary Exam Date	Weight (Kg)	Blood Sample Taken
4A7105	F	2	06/18/04	2.35	yes
47E09	M	1	06/17/04	2.3	yes
47304	F	2	06/19/04	2.15	yes
51E3E	M	2	06/16/04	2.9	yes
52E0D	F	1	06/17/04	2.55	yes
53723	M	2	06/17/04	2.4	yes
60B1D	F	3	06/17/04	2.4	yes
60D24	M	1	06/16/04	2.4	yes
63F2A	F	2	06/18/04	2.25	yes
70518	M	4	06/18/04	2.5	yes
7235F	M	juvenile	06/19/04	1.3	yes
73D0D	M	5	06/17/04	2.2	yes
7305C	M	juvenile	06/18/04	1.4	yes
75125	M	3	06/17/04	2.8	yes
7792E	M	2	06/17/04	2.55	yes
80C3F	M	juvenile	06/18/04	1.4	yes
84F28	M	4	06/17/04	2.75	yes
85420	M	juvenile	06/17/04	1.4	yes
9230A	M	juvenile	06/19/04	1.25	yes
95B34	F	5	06/17/04	2.2	yes
95906	F	2	06/17/04	2.35	yes
96C2E	F	3	06/17/04	2.45	yes

## Health/Medical

Dr. Mark Willett, D.V.M., and Dr. Winston Vickers, D.V.M., performed veterinary examinations on captive Santa Rosa Island foxes in June 2004 (Table 15). At time of examination, blood samples were taken from all animals and processed by IDEXX Laboratories (Sacramento, California) for hematology and complete blood chemistry. All captive foxes were vaccinated against canine distemper virus with a Canary pox vectored recombinant vaccine (Purevax Ferret Distemper vaccine, Merial, Inc., Athens, GA). Island foxes are normally vaccinated during annual veterinary examinations. Due to a nationwide shortage of the vaccine, island foxes were vaccinated in December 2004.

There were two mortalities among captive foxes on Santa Rosa in 2004 (Table 16). First, female B715F, unmated and born in 2002, died on February 3, 2004, of injuries apparently inflicted by at least 1 of her 3 penmates, all of which were unmated females. Second, male D3D76 died of chronic kidney failure on March 5, 2004. D3D76 was a wild-born founder who had sired 8 pups in captivity and had the most descendants (19) of any founder. The chronic kidney failure was confirmed by the elevated concentrations of compounds normally filtered by kidney byproducts (blood urea nitrogen and creatinine) in annual blood

samples. One fox, female 95B34, died in captivity in February 2005, likely from aspiration pneumonia. The deaths of the 3 foxes bring the total number of captive deaths on Santa Rosa, since 2000, to 3. In March 2001, founder female A7015 died of cancer.

**Table 16. Island fox mortalities, Santa Rosa Island, 2004-2005.**

PIT tag	Release ID	Sex	Age	Date	Specimen Depository <sup>1</sup>	Area	Mortality Cause
B715F	--	F	2	02/02/2004	UCD	In captivity	Trauma inflicted by penmate
13C24	101	F	2	02/20/2004	I	Trap Canyon	Golden eagle predation
D3D76	--	M	3	03/05/2004	UCD	In captivity	Chronic kidney failure
C586D	116	F	3	11/16/2004	I	Trap Canyon	Golden eagle predation
4A7105	114	F	3	11/20/2004	I	San Augustin Canyon	Golden eagle predation
7305C	07	M	0.5	12/30/2004	I	Black Mountain	Golden eagle predation
E5100	115	F	4	01/22/2005	I	Black Mountain	Golden eagle predation
A045A	M03	M	3	02/05/2005	UCD	Becher's Bay ranch	Unknown; stuck in PVC pipe
95B34	--	F	3	02/15/2005	UCD	In captivity	Aspiration pneumonia
51E3E	M05	M	2	03/30/2005	UCD	Verde Canyon	Golden eagle predation

<sup>1</sup>UCD = UC Davis Veterinary Medical Teaching Hospital

I = Insufficient material for analysis

Foxes examined were in generally good or excellent condition, with a few exceptions. There have been 3 cases of rectal prolapse in a total of 2 foxes since 2000. One fox, male F3D2F, prolapsed during veterinary examination in August 2002, at which time the rectum was repaired with a purse-string suture. F3D2F suffered another prolapse in March 2004, again requiring a suture. A mass on the side of his rectum may have caused the prolapse; the mass itself may have been caused by the parasite *Spirocerca*, for which F3D2F has tested positive (Karl Hill, DVM, Santa Barbara Zoo, pers. comm., S. Patton, University of Tennessee, unpubl. data). Consequently, F3D2F was treated with Doramectin in 2004.

Foxes on Santa Rosa have more problems with ectoparasites (fleas and ticks) than do San Miguel foxes. All foxes were treated with Frontline (Merial Ltd., Athens, GA) during 2004 vet exams.

## Male-Female Aggression in Captivity

Five captive males have injured females during the breeding season (Table 17). In 3 cases problems occurred shortly (1-2 mos.) after pairing and may be due to incompatibility, but in 3 other cases male aggression occurred after the respective pair spent a considerable time (19-43 mos.) together. Four of the 6 cases occurred in spring 2004, when some of the released foxes had returned to the captive breeding facilities and were involved in agonistic encounters with captive foxes. Construction of perimeter fences around the facilities in 2004, coupled with a greater tendency of released foxes to establish activity areas away from the captive facilities, may have alleviated much of the problem. There have been no such male-caused injuries in spring 2005.

**Table 17. Incidence of male aggression toward females among captive island foxes on Santa Rosa Island.**

Date Separated	Female	Male	Time Together	Injuries Sustained	Management Action
05/14/2003	96C2E	75125	19 mos.	Head wounds	96C2E was re-paired with 37E00 75125 was re-paired with C586D
11/25/2003	C586D	75125	1 mos.	Ear injuries	C586D was released in October 2004 75125 was released in December 2003
01/16/2004	10445	B4B2B	2 mos.	Back, eye and ear wounds	Both released in November 2004
01/20/2004	25D54	D4C78	2 mos.	Head and ear wounds	25D54 re-paired with 80C3F D4C78 was released in November 2004
05/10/2004	D187A	0654E	43 mos.	Broken leg, ear injuries	Both currently housed separately
05/13/2004	07061	51E3E	19 mos.	Head wounds	07061 was re-paired with 7235F 51E3E was released in October 2004

Four of the 5 males involved in mate aggression were removed from mating pens and released to the wild, and another is now housed individually, both actions resulting in effective loss of potential breeding pairs in captivity. Although male-male and male-female aggression is characteristic during island fox breeding season (D. Garcelon, Institute for Wildlife Studies, personal communication), foxes held in captivity may suffer greater injury due to the inability to escape from an aggressive mate. Some pen aggression may be due to food competition (W. Vickers, Institute for Wildlife Studies, personal communication), whereas other cases of male-female aggression may be due to incompatibility, and therefore implementing mate-choice for pair formation may prevent aggression in such cases. On the other

hand, some males may have more of a tendency toward such behavior, and may therefore simply be poor candidates for breeding in captivity. Alternatively, those males are better candidates for release to the wild.

One male fox (75125) was a repeat offender, injuring a second female (C586D) after being separated from a previous potential mate, 96C2E. Once released to the wild 75125 subsequently paired up in the wild with another released captive fox (95906), in an apparent case of natural mate-choice. The pair was brought back into captivity in February 2004 because their use area included the captive facilities. Although they did not produce a litter in 2004, the pair is cohabiting in captivity without further problem.

### ***Reintroduction of Santa Rosa Island Foxes***

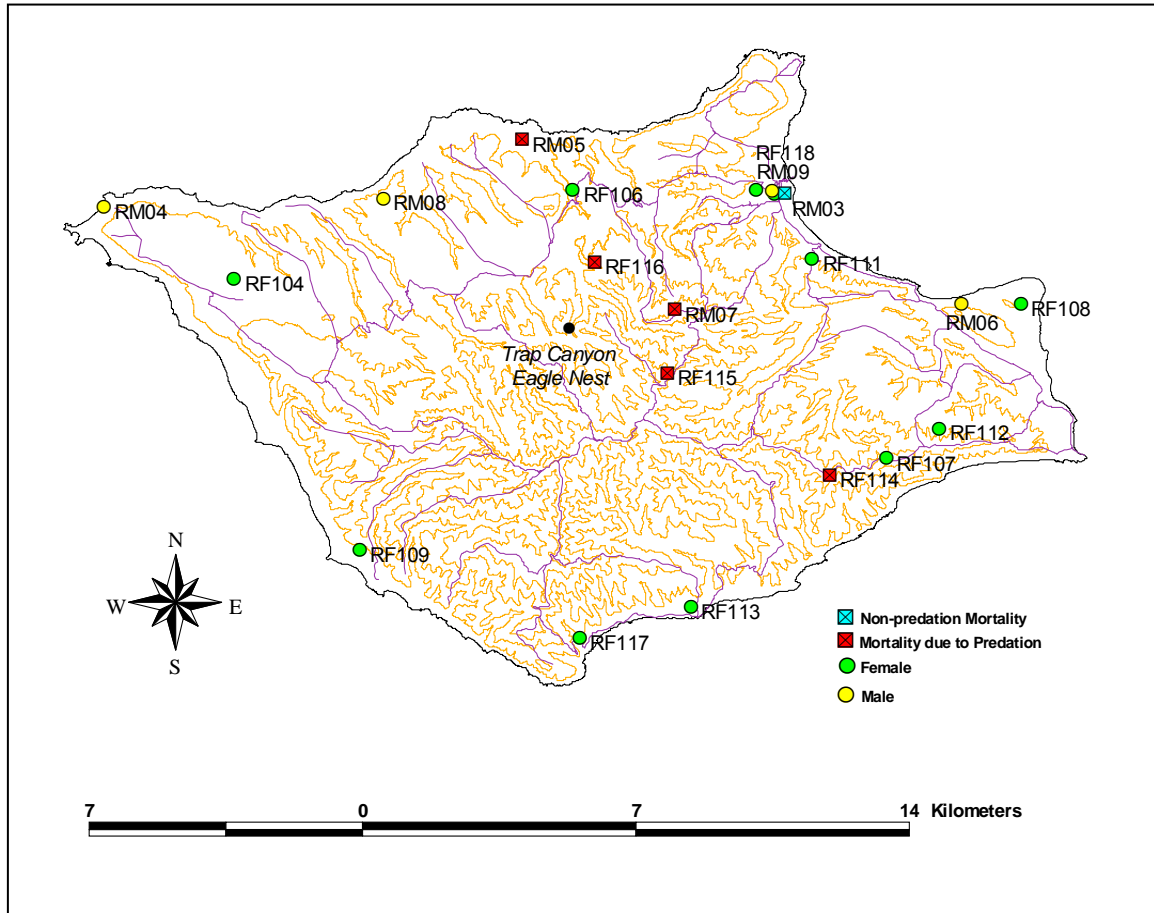
As of May 15, 2005, there were 14 foxes in the wild on Santa Rosa Island (Fig. 6): 8 from the fall 2004 release, 5 from the 2003 fall/winter release, and 1 fox born in the wild in April 2004.

### **Results of 2003 Release**

Of the 12 foxes from the initial release in fall/winter 2003/2004, 1 died from eagle predation and 5 were returned to captivity because their activity areas included the two captive breeding facilities (Coonan et al. 2004). Two of the remaining 6 foxes from the initial release mated and produced a litter in the wild. Male M03 and female RF106 established a territory in Windmill Canyon (Fig. 5) and weaned 2 female pups. One pup, D0F75, was captured and PIT-tagged on July 10, 2004, and then was re-captured on December 11, 2004, radiocollared and released as female RF118. The other pup, A5E60, was captured on October 19, 2004, brought into captivity, and paired with male 9230A for the 2004-2005 breeding season.

The sire and dam of this wild litter had been paired in captivity from 2000-2003 and had failed to reproduce. The dam, RF106 (PIT tag 33131) was wild-born, and so her production of a litter in the wild makes her an additional (12<sup>th</sup>) founder for the Santa Rosa population. For this reason, one of her pups was brought into captivity for breeding.

The sire of the wild litter, male M03, died on February 5, 2005 from trauma due to injuries sustained when he became lodged in a vertical PVC pipe housing a sprinkler head in the Becher's Bay ranch complex.



**Figure 4. Most recent radiotelemetry locations of wild island foxes on Santa Rosa Island, as of 15 May 2005.**

### Results of 2004 Release

Thirteen foxes (7 female, 6 male) were released to the wild between 22 October and 07 November 2004 (Table 18). As of 15 May 2005, 5 of the 13 released foxes had died due to eagle predation (as indicated by condition of carcasses and presence of eagle down at kill sites).

Six foxes were released in the Torrey Pines area, and 7 in Lobo Canyon. The Lobo Canyon site was used instead of the Arlington Canyon site because the road to the Arlington Canyon release site had been rendered impassable by recent precipitation. No foxes were returned to captivity because of unacceptable weight loss

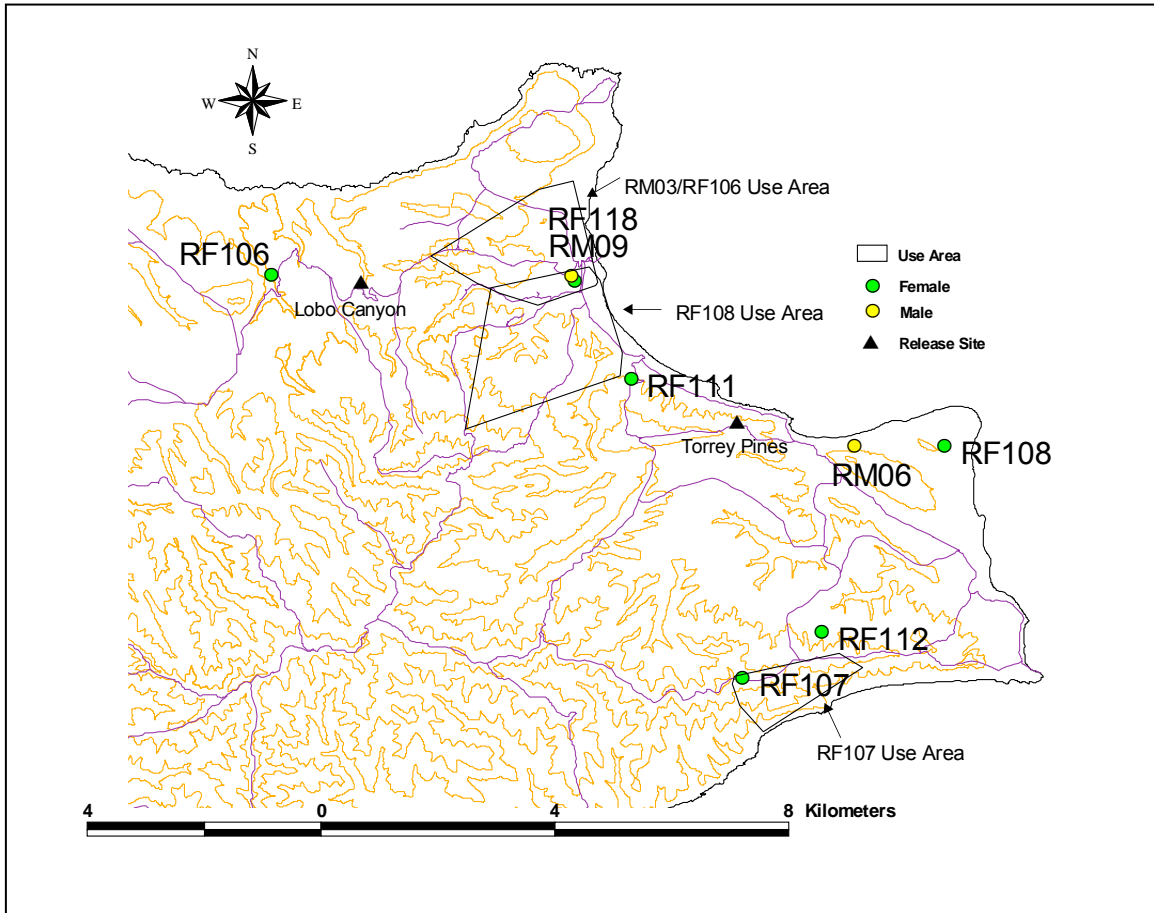


after release. Most released foxes moved away from the release areas in the first week post-release. Several females dispersed to the southeast or southwest areas of the island, where 2 unmated females from the previous release had established use areas (Fig. 4).

**Table 18. Release location, date, release type and fate of foxes released to the wild on Santa Rosa Island, fall 2004.**

PIT tag	ID	Sex	Age	Date	Release Type <sup>1</sup>	Area	Fate
B4B2B	04	M	4	10/22/2004	P	Torrey Pine	In wild
F3950	111	F	3	10/22/2004	P	Torrey Pine	In wild
51E3E	05	M	2	10/22/2004	P	Torrey Pine	Died 03/30/2005 from predation Collar failed 10/22/2004
37C61	112	F	4	10/22/2004	P	Torrey Pine	
7792E	06	M	2	10/22/2004	P	Torrey Pine	In wild
4A710 5	114	F	3	10/22/2004	P	Torrey Pine	Died 11/20/2004 from predation
7305C	07	M	0.5	10/29/2004	P	Lobo Canyon	Died 12/30/2004 from predation
E5100	115	F	4	10/29/2004	P	Lobo Canyon	Died 01/22/2005 from predation
D4C78	08	M	1	10/30/2004	S	Lobo Canyon	In wild
03332	09	M	0.5	10/30/2004	P	Lobo Canyon	In wild
C586D	116	F	3	10/30/2004	P	Lobo Canyon	Died 11/16/2004 from predation
2571A	113	F	2	11/07/2004	Gr	Lobo Canyon	In wild
10445	117	F	3	11/07/2004	Gr	Lobo Canyon	In wild

<sup>1</sup>P = mated pair  
Gr = Group  
S = single animal



**Figure 5. Recent radiotelemetry locations of wild island foxes on Santa Rosa Island in relation to use areas of foxes released in fall/winter 2003/2004.**

Whereas the foxes from the first release were released into unoccupied territory, those released in fall 2004 were released into a situation in which foxes from the first release had established territories (Fig. 5). Use areas shifted as recently released foxes interacted with foxes from the previous release. Four pairs established breeding territories in spring 2005, and at least 8 pups were known to have been born in the wild, as of August 1, 2005.

RF118, the female born in the wild in 2004, paired with male M09 and took over the territory used the previous year by RM03 and RF106, her parents. RF118 and RM09 produced a litter of 3 pups in spring 2005.

The territory used by RF118 and RM09 was vacant due to the death of RM03 in February 2005 and the subsequent movement of his mate RF106 to the west, possibly to establish a breeding territory with male RM05. However, RM05 died due to eagle predation on March 30, 2005. Nonetheless, RF106 produced a litter of 2 pups in Verde Canyon in spring 2005.

RF104 and RM08 produced a litter of 3 pups in Soledad Canyon, on the west end of the island.

The fourth possible pair involved female RF108, which was released on January 19, 2004, and had established a use area adjacent to that of RM03 and RF106 (Fig. 7). After the fall 2004 release, RF108 moved east to the Skunk Point area, where she may have established a breeding territory with recently released male RM06. However, no pups were recorded on a remote camera set up at Skunk Point

Unlike last year's release, few wild foxes have been recorded near the captive facilities, and no injuries to captive foxes are likely attributed to interaction with wild foxes. This is likely due to completion of the perimeter fences around the Windmill Canyon and Caballo del Muerto captive breeding sites.

Foxes were released as pairs or as same-sex groups. Prior to release, foxes slated for release either as pairs or groups were housed in captivity with their release-mates for a period of 6-15 days. No members of any pair released together are still traveling together. In part this may be due to the deaths of 5 released foxes from predation.

Three supplemental feeding stations were established in the Torrey Pines release area, and three in the Lobo Canyon release area. Supplemental feeding was conducted at the stations for a period of 5 weeks following the initial releases. Stations were provisioned with 120-150 g of dry dog kibble, and were re-provisioned 2-4 times a week. Consumption of food ranged from 17-100%.

All island foxes were released at weights that were higher than average weights of wild foxes. Average release weight for the 7 females was 2.72 kg, and average release weight for the 6 males was 2.87 kg (Table 19).

Of the 5 released foxes that died from eagle predation, 3 died on or near Black Mountain, suggesting that released foxes may be more vulnerable to predation near this high point. This may be due to several factors. First, these highlands may be frequented more often by hunting golden eagles than other parts of the

island. Second, the area is near the Trap Canyon golden eagle territory and nest, the only recent active eagle territory on the island. The Trap Canyon adults bred in spring 2005, and a juvenile thought to be fledged by the pair last year was caught in a bownet trap set near Trap Canyon on February 5, 2005 (D. Driscoll, Institute for Wildlife Studies, pers. comm.). Third, Black Mountain forms the central highland of the island and is thus most likely to be traversed by dispersing foxes. At the same time, its bare ridges may offer less cover from aerial predators than other areas.

**Table 19. Capture dates and weights for island foxes released to the wild, 2003-2004, Santa Rosa Island.**

Fox ID	Capture Date	Weight	Release Site	Comments
F101	11/20/2003	2.75	Lobo Canyon	Release
	12/22/2003	1.85		Returned to captivity due to weight loss
	1/7/2004	2.30	Upper Soledad	Re-released to the wild after weight gain
	1/29/2004	2.00		Died due to predation 02/20/2004
F102	11/21/2003	2.50	Lobo Canyon	Release
	12/16/2003	2.65		
	1/7/2004	1.95		
	1/30/2004	2.00		Returned to captivity 01/30/2004
F103	11/21/2003	2.50	Lobo Canyon	Release
	12/16/2003	2.20		
	12/19/2003	2.20		
	1/17/2004	2.20		
	1/22/2004	2.20		
	2/8/2004	2.40		Returned to captivity 02/08/2004
F104	11/21/2003	2.80	Lobo Canyon	Release
		2.10		Returned to captivity due to weight loss
	11/29/2003			
	1/13/2004	2.15	Carrington	Re-released to the wild after weight gain
	1/26/2004	1.95		
F106	11/30/2004	2.10		
	1/17/2004	3.05	Arlington	Release
	2/7/2004	2.50		
	6/14/2004	2.20		
	7/10/2004	2.30		
F107	10/9/2004	2.50		
	1/19/2004	2.60	Tecolote	Release
F108	1/19/2004	2.85	Tecolote	Release
	2/1/2004	2.50		
	3/6/2004	2.10		
	3/18/2004	2.30		
	11/21/2004	2.40		

<b>Fox ID</b>	<b>Capture Date</b>	<b>Weight</b>	<b>Release Site</b>	<b>Comments</b>
F109	2/5/2004	2.35	Tecolote	Release
	12/14/2004	2.50		
F110	2/5/2004	2.60	Tecolote	Returned to captivity 05/20/2004
F111	10/22/2004	3.10	Torrey Pines	Release
	11/21/2004	2.75		
F112	10/22/2004	2.40	Torrey Pines	Collar malfunction as of 10/26/2004
F113	11/7/2004	2.35	Lobo Canyon	
F114	10/22/2004	2.80	Torrey Pines	Died due to predation 11/20/2004
F115	10/29/2004	3.10	Lobo Canyon	Died due to predation 01/22/2005
	11/16/2004	2.30		
F116	10/30/2004	2.70	Lobo Canyon	Died due to predation 11/16/2004
F117	11/7/2004	2.50	Lobo Canyon	
F118	07/10/2004	1.05		First capture of pup born in wild April 2004, PIT D0F75; released Radiocollared and released
	12/11/2004	2.00		
--	07/13/2004	1.0		First capture of pup born in wild April 2004, PIT A5E60 Brought into captivity In captivity
	10/09/2004	1.7		
	12/15/2004	1.9		
M01	11/20/2003	3.13	Lobo Canyon	
	11/29/2003	2.70		
	12/16/2003	2.55		
	1/7/2004	2.25		
M02	12/8/2003	2.80	Lobo Canyon	Returned to captivity 01/06/2004
	1/22/2004	2.20		
	1/30/2004	2.35		
M03	1/17/2004	2.70	Arlington	
	2/8/2004	2.30		
	3/6/2004	2.00		
	7/11/2004	2.35		
	10/9/2004	2.60		
	11/16/2004	2.60		
M04	10/22/2004	3.30	Torrey Pines	Died 02/05/2005 while stuck in a PVC pipe in the Becher's Bay ranch area
	11/3/2004	2.65		
M05	10/22/2004	2.90	Torrey Pines	
	11/28/2004	2.50		
M06	10/22/2004	2.80	Torrey Pines	
M07	10/29/2004	2.90	Lobo Canyon	Died from predation 12/30/2004
	11/16/2004	2.45		
	11/30/2004	2.05		
M08	10/30/2004	2.70	Lobo Canyon	
	11/27/2004	2.20		
M09	10/30/2004	2.60	Lobo Canyon	

The 5 foxes which died from predation were from the 2004 release group. Newly released animals may be more vulnerable than other

wild animals, simply because the former have a tendency to disperse from the release area to establish use territories and seek mating opportunities. This movement alone may render them more vulnerable than foxes which have already established territories. The vulnerability of foxes released in the future might be reduced, first of all, by capturing and relocating the existing eagles, but also by releasing foxes earlier in the fall to give them more time to establish stable use areas, and releasing them well away from the Black Mountain area.

### ***Future Management of Santa Rosa Island Foxes***

Ten to 20 additional Santa Rosa Island captive foxes will be released in fall 2005, the final number dependent upon the recommendations of the island fox Recovery Coordination Group. Pups born in 2005 will be PIT-tagged. All captive foxes will be given veterinary examinations, will have blood samples drawn for testing, will be vaccinated against canine distemper virus and rabies, and will be given veterinary treatment as required for injuries and other medical conditions. Foxes will be released to the wild under an annual release plan developed in summer 2005.

It is estimated that captive breeding and annual releases will continue for approximately 10 years, until Santa Rosa island foxes have reached a target population size (Coonan 2003) which insures the likelihood of persistence.



*Santa Rosa  
Island, 2004*

*Geoff Cline*

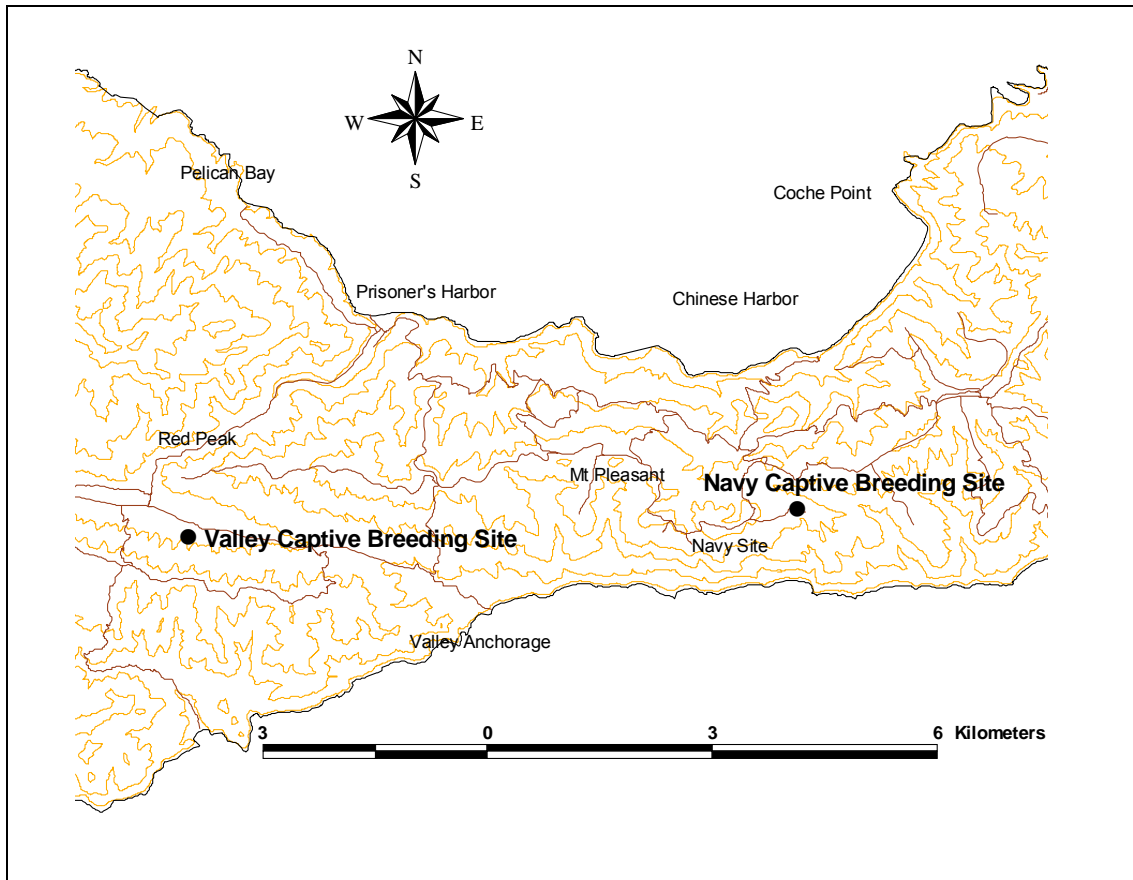


Figure 6. Location of island fox captive breeding facilities, Santa Cruz Island.

## Recovery of Santa Cruz Island Foxes

The captive island fox population on Santa Cruz Island grew to 42 foxes in spring 2004 with the addition of 19 pups (Table 20). No foxes were released to the wild in 2004, due to golden eagle presence on the island. By the end of 2004 over 70 radiocollared wild foxes were being monitored, and annual survivorship had increased to over 80%.

### *Captive Breeding*

A second captive breeding facility, the Central Valley site (Fig. 8) was completed in 2004. There are 12 breeding pens at the Central Valley site and 10 breeding pens at the Navy site.

Eight of 11 pairs (73%) produced litters in 2004. Of the 19 pups born in captivity, 9 were male, and the current sex ratio in captivity is 19M:23F. One new founder (female 16C30) bred in

captivity in 2004, bringing the total number of founders for the Santa Cruz captive population to 15. There are an additional 4 potential founders currently in captivity which have not yet produced litters. Unlike on San Miguel and Santa Rosa Islands, the number of founders could be increased on Santa Cruz Island by bringing additional wild foxes into captivity.

New pairings were implemented for Santa Cruz island foxes in October 2004, according to the recommendations of the AZA's population management plan for island foxes (Lynch 2004). Three existing pairs were broken up, and 11 new pairs were created. For the 2004-2005 breeding season there were 19 pairs.

**Table 20. Reproductive success of captive Santa Cruz Island foxes, 2003-2004 breeding season.**

Pen	PitTag	Sex	Age <sup>1</sup>	Paired	Result	Litter Size
C01	A4628	M	7			
C01	30B2D	F	5	3/11/2002	Litter	2
C02	A6D41	M	4			
C02	D2C13	F	4	3/1/2002	Litter	2
C03	1415A	M	4			
C03	0786F	F	6	3/3/2002	NL	0
C04	B506A	M	4			
C04	71B0E	F	4	1/15/2003	Litter	3
C05	36172	M	5			
C05	72901	F	4	2/27/2002	Litter	3
C06	86B1A	M	4			
C06	86F17	F	4	3/10/2002	Litter	3
C07	45411	M	4			
C07	D2210	F	3	3/11/2002	Litter	2
C08	C3E7E	M	1			
C08	44D52	F	1	12/10/2003	NL	0
C09	1783E	M	7			
C09	87035	F	6	12/4/2002	Litter	1
C10	02361	M	1			
C10	D3035	F	1	12/10/2003	NL	0
C22	F3F0E	M	1			
C22	16C30	F	3	3/1/2004	Litter	3

<sup>1</sup>in years, as of spring 2004

## Health/Medical

Captive Santa Cruz Island foxes received veterinary examinations from project veterinarian Mark Willet, DVM, in June 2004. Routine general physical examinations were performed in a nose to tail fashion, and included otoscopic examination. Blood samples were obtained from all animals for complete blood chemistry analysis.



Foxes were generally in good or excellent health, although all required treatment for ectoparasites. All captive foxes were vaccinated against canine distemper virus with a Canary pox vectored recombinant vaccine (Purevax Ferret Distemper vaccine, Merial, Inc., Athens, GA). Island foxes are normally vaccinated during annual veterinary examinations. Due to a nationwide shortage of the vaccine, island foxes were vaccinated in December 2004.

### ***Reintroduction of Santa Cruz Island Foxes***

Of 9 captive foxes released to the wild on Santa Cruz Island in fall/winter 2003/2004, 5 were killed by golden eagles within 10 days of release (Coonan et al. 2004), underscoring the apparently high vulnerability of released captive foxes to predation. Because as many as 10 golden eagles remained on Santa Cruz Island after eagle capture efforts were completed in 2004 (see Removal of Golden Eagles, below), the continued risk of predation was deemed too high to allow for release of captive foxes. Therefore, no foxes were released from captivity on Santa Cruz Island in fall/winter 2003/2004.

### ***Future Management of Santa Cruz Island Captive Foxes***

The 19 pairs currently in captivity are likely to produce 10-20 pups in spring 2005, increasing the captive population to as many as 60+ foxes. Current capacity is 20 pairs, or 40 foxes. If foxes cannot be released to the wild in fall 2005 because of the threat of eagle predation, then additional pens must be built to accommodate the growing population.

### ***Status of Wild Fox Population***

The survivorship of radiocollared foxes on Santa Cruz Island is a measurement of the relative success of eagle removal in reducing predation as a mortality factor. Since December 2000, the Institute for Wildlife Studies has conducted monitoring of the Santa Cruz wild fox population via radiotelemetry. The number of foxes monitored increased over the study period from approximately 20 in 2000 to over 70 in 2004 (D. Garcelon, Institute for Wildlife Studies, unpubl. data).

From December 2000 through May 2005, golden eagle predation was identified as the cause of mortality for 27 (87%) of 31 wild foxes that died (Table 21). Other causes of mortality included compressive trauma due to collapse of a dead tree, and septicemia caused by a rectal prolapse and a *Spirocerca* infection. For 2

mortalities, cause of death could not be determined (L. Munson, University of California, Davis, unpubl. data).

**Table 21. Mortalities of wild radiocollared foxes, Santa Cruz Island, December 2000 - May 2005.**

Date	ID	Sex	Age <sup>1</sup>	Mortality Cause
3/23/2001	M5	M	1	Predation
5/23/2001	F7	F	A	Predation
6/1/2001	F1	F	A	Predation
6/13/2001	M13	M	4	Predation
8/24/2001	M23	M	1	Predation
9/29/2001	F4	F	2	Predation
11/16/2001	M17	M	1	Predation
11/17/2001	F11	F	1	Predation
11/17/2001	M4	M	1	Undetermined
3/3/2002	F36	F	1	Predation
3/28/2002	M12	M	2	Predation
4/11/2002	M19	M	1	Predation
8/16/2002	M11	M	3	Undetermined
11/9/2002	M15	M	1	Compressive trauma
1/23/2003	F39	F	1	Predation
1/31/2003	M49	M	1	Predation
4/10/2003	M6	M	2	Predation
11/14/2003	F45	F	3	Predation
12/3/2003	F2	F	4	Rectal prolapse with septicemia
1/24/2004	F78	F	1	Predation
2/7/2004	F65	F	1	Predation
2/22/2004	F80	F	1	Predation
3/7/2004	M76	M		Predation
3/15/2004	F62	F	1	Predation
5/7/2004	F25	F		Predation
5/18/2004	F27	F	2	Predation
7/29/2004	M58	M		Predation
1/20/2005	F74	F		Predation
2/20/2005	F119	F		Predation
5/19/2005	M93	M		Predation
5/28/2005	F83	F	2	Predation

<sup>1</sup>in years; A = adult of unknown age

Over the study period wild fox mortality due to golden eagles declined, and annual survivorship of wild island foxes increased from 61% to over 90%, likely due to removal of golden eagles (Fig. 7). Annual survivorship of 80% is the level determined by demographic modeling to be necessary for a stable or increasing

fox population (Coonan 2003, Roemer et al. 2001). Survivorship in 2004 (86%, 95% CI = 78-95%) approximated island fox survivorship values recorded prior to the decline of island foxes (83%; Roemer 1999).

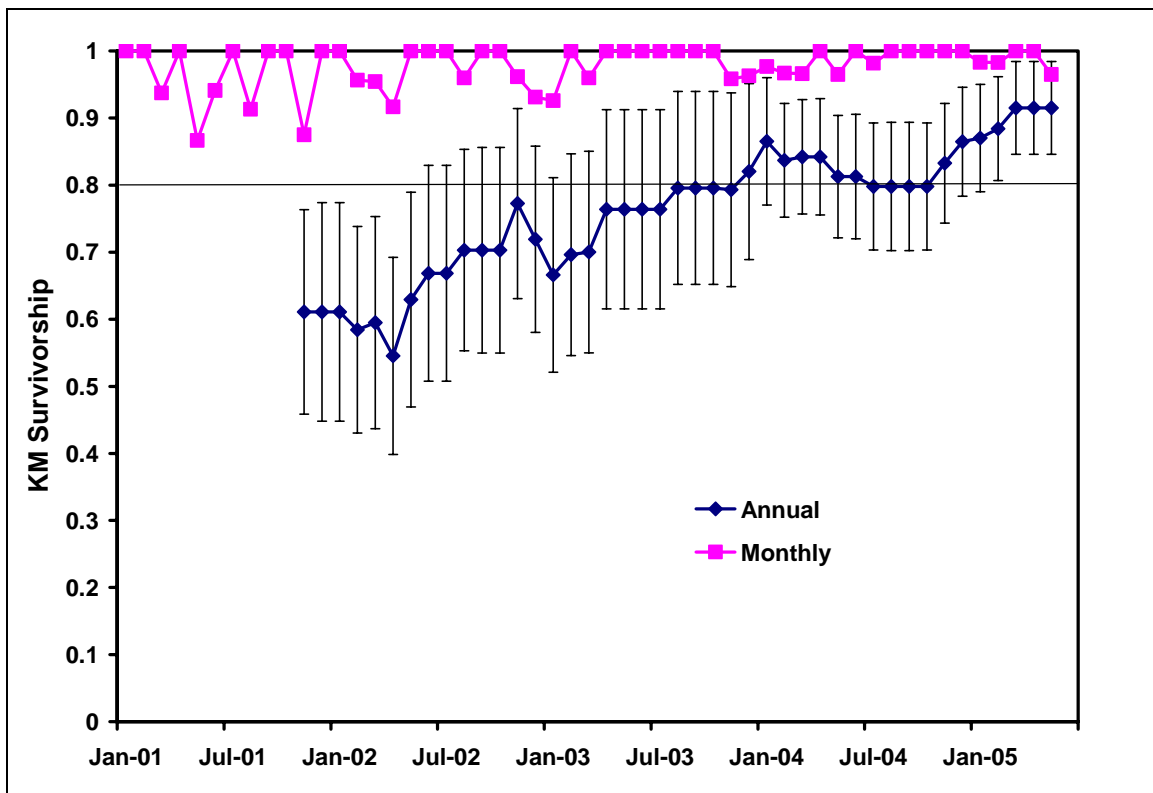


Figure 7. Annual and monthly Kaplan-Meier survivorship for wild island foxes, Santa Cruz Island, 2001-2005.

## **Removal of Golden Eagles**

In 2004 staff from the Santa Cruz Predatory Bird Research Group (SCPBRG) completed a 5-year effort to remove golden eagles from the northern Channel Islands (Latta 2005). A total of 6 golden eagles (2 adult males, 1 adult female, and 3 nestlings) were removed from the islands in 2004, bringing the total removed over the 5-year period to 37 (Fig. 8). Males comprised the bulk (20) of the 29 non-hatchling eagles removed. As many as 12 eagles remained on the islands at the end of 2004. The remaining birds included 6 adult females, 3 adult males and 3 subadult eagles.

## **Removal Methods**

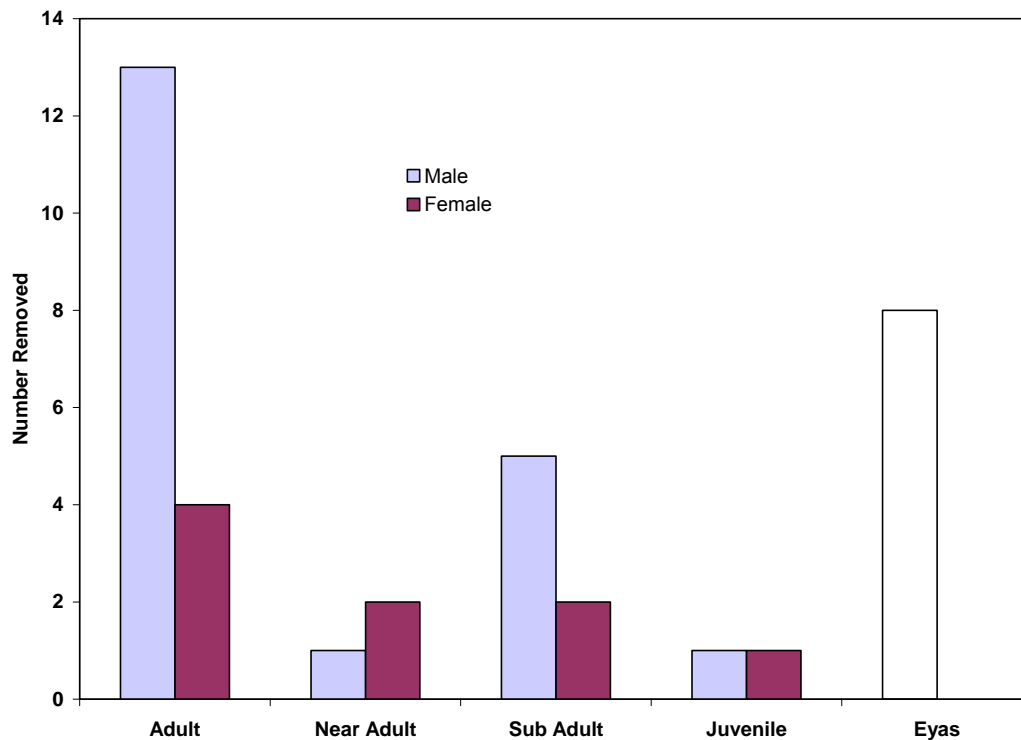
In 1999 NPS established a cooperative agreement with the SCPBRG for relocation of golden eagles from the northern Channel Islands, and in recent years The Nature Conservancy has funded eagle removal by SCPBRG via a contract. Total cost of the project over the 5 year period was over \$771,677 (Latta 2005).

The primary technique used for eagle capture was a dug-in, radio-controlled bownet placed in areas that eagles frequented (Jackman et al. 1994). Bait used included dead feral pigs, live feral pigs, and live rabbits. In a typical set, the bownet was set in place prior to dawn. If an eagle alighted on the prey, the net was deployed via radio signal from a distant hidden observation point. Captured eagles were banded and measured, and transported in large commercial sky kennels modified for raptor transport. Most captured eagles were flown off the island by the morning following capture, and then driven or flown by commercial airliner and driven to one of several release sites, east of the Sierra Nevada range. Releases occurred usually within 24 hours of capture.

Eagle nest sites during the breeding season offer the best potential for eagle capture, due to the investment of the parents in the breeding attempt and their need to provide growing hatchlings with food. Within the breeding season, the optimal time to attempt capture is when the hatchlings are at least 3 weeks old. At this age their food requirements are high, insuring that adults are prone to hunt and therefore likely to visit baited trap sites. Additionally, the hatchlings are large enough to thermoregulate on their own and can survive long periods of adults being away from the nest. Moreover, eagles disturbed during incubation will abandon more readily than will eagles disturbed (for example, by trapping attempts) during the hatchling phase.

## Results of 2004 Removal Efforts

Over the 5-year period golden eagles used at least 10 different breeding territories, 8 on Santa Cruz and 2 on Santa Rosa. In 2004 eagle nesting attempts reached the incubation phase at 3 nests: El Tigre/Laguna Canyon and Lady's Canyon territories on Santa Cruz, and the Trap Canyon territory on Santa Rosa. In March 2004 eagle capture crews were preparing to attempt capture of adult eagles at the El Tigre and Trap Canyon nests. However, eagle pairs at both sites abandoned their nesting attempts at the end of March, perhaps due to unseasonably warm weather. The Trap Canyon pair was not observed again until early 2005. The El Tigre pair re-nested in Laguna Canyon, a fact made apparent when mortality signals from 2 radiocollared island foxes were tracked to the nest site. Capture attempts at that nest netted the adult male, and a hatchling was hand-captured at the nest. Trapping efforts then shifted to the Lady's Canyon nest site on the north shore of Santa Cruz. The adult female and 2 hatchlings were captured there in June 2004.



**Figure 8. Sex and age class of golden eagles removed from Santa Cruz and Santa Rosa Islands, 1999-2004.**

Thus in 2004, 1 member was captured from each of 3 breeding pairs (Cascada, Laguna Canyon, and Lady's Canyon) and at least two intact adult pairs remained. The latter included the Trap Canyon pair on Santa Rosa Island, and the Christy/Watertank pair on the west end of Santa Cruz (in 2004 the Christy/Watertank pair abandoned their nesting attempt prior to egg-laying, but remained in the general area).

### ***Future Plans for Eagle Removal***

Because golden eagles remaining on the islands represent a threat to wild foxes and to foxes released from captivity, eagle removal efforts will continue in 2005, funded by The Nature Conservancy and NPS. Future eagle removal efforts will focus on removal of adult nesting females. Breeding females have proved difficult to capture. Only 4 breeding females were captured in the 5-year period, compared to 13 breeding males. In several cases where the male member of a breeding pair was captured, the female successfully bred the following year with a new male (Latta 2005).

Over the 5 years of the current eagle removal project, eagles became increasingly difficult to remove, and the likely rate of success for future eagle removal is unknown. Because success of island fox recovery efforts hinges upon reducing the impacts of eagle predation on island foxes, it is important to estimate the likelihood of future dispersal of mainland eagles to the islands. For this reason, a research project is under way to estimate the relatedness and source (island versus mainland) of the eagles removed thus far from the islands. If most of the eagles are of island origin, then the rate of dispersal from the mainland may be low, and current removal efforts, coupled with pig removal and bald eagle reintroduction efforts, may eventually allow for fox recovery.

The ability of golden eagles to breed and roost on the islands depends upon food availability. Availability of some prey will change in the short-term. For example, feral pigs are currently being removed from Santa Cruz Island. On Santa Rosa Island, over 400 non-native mule deer (*Odocoileus hemionus*) and 700 elk (*Cervus elephus*) provide both carcasses and live prey (fawns) for golden eagles, but both those ungulate species will be removed by 2011 according to the terms of a negotiated settlement (National Park Service 1997). If those non-native ungulate species provide significant food resources for golden eagles, then their removal should reduce the ability of the islands to support golden eagles. To determine the relative importance of various native and non-native prey species to golden eagles, Paul Collins of the

Santa Barbara Museum of Natural History is conducting a study of prey remains found in golden eagle nests on Santa Cruz and Santa Rosa Islands.

## **Other Actions Required for Recovery**

The immediate actions required for island fox recovery are captive breeding of island foxes and removal of golden eagles. Additional, longer term actions required for island fox recovery include removal of pigs from Santa Cruz Island, and reintroduction of bald eagles to the northern Channel Islands (Coonan 2003). The former is required to remove an alien prey base that supports golden eagle use of the islands, and the latter is required to return bald eagles to their former role as apex predator in the system. It is possible that breeding bald eagles may deter future golden eagle use of the islands.

### ***Removal of Feral Pigs from Santa Cruz Island***

With environmental compliance and planning completed (NPS 2002) and funding secured from both The Nature Conservancy and the NPS, a contractor was selected by TNC in 2004 and pig removal efforts began in early 2005. Removal of pigs should be completed within 2-4 years, and the majority of the pigs may be removed very quickly, perhaps within 1-2 years.

### ***Reintroduction of Bald Eagles to Santa Cruz Island***

In 2002, the Institute for Wildlife Studies began a feasibility study to determine if bald eagles could be successfully reintroduced to the northern Channel Islands. The study is funded by settlements monies from the Montrose Settlements Restoration Program (NOAA et al. 2002), because the disappearance of bald eagles from the Channel Islands in the mid-20th century was due to the effects of organochlorine contaminants in the marine ecosystem of southern California. As of spring 2005 there were over 25 juvenile bald eagles on the northern Channel Islands, as a result of summer reintroductions in summer 2002 - 2004.

The goal of the study is to release up to 12 juvenile bald eagles annually on the northern Channel Islands for 5 years, and to monitor released eagles and their prey for contaminant levels to determine if levels are sufficiently low to allow breeding. Twelve juvenile eagles were released from hawk towers on Santa Cruz Island in 2002, 11 in 2003, and xx in 2004. Because bald eagles mature at 4-5 years of age, birds from the first (2002)

release group may begin breeding in 2006 or 2007. As of spring 2004, 7 eagles from the 2002 release and 8 released in 2003 were alive on the islands (Garcelon 2004). Two released birds dispersed to the mainland and are currently in Utah and Oregon, respectively. The remaining 6 eagles died, likely from attempting to cross the Santa Barbara Channel.

Bald eagles from both release years have been recorded on Santa Rosa Island during late fall and winter. Released bald eagles have been observed feeding on carcasses and gut piles from the commercial hunt and annual cull of mule deer and elk on that island.

The long-term success of eagle reintroduction efforts on the northern Channel Islands depends on contaminant levels in eagles and their prey, and attendant effects upon eagle reproduction. In 2005, baseline and recapture blood samples for released eagles will be tested for DDT and PCB, as will samples from eagle prey items (marine fishes, seabirds, and pinniped carcasses).

**Table 22. Costs incurred by the NPS, by funding source, for island fox recovery actions in fiscal year 2004 (October 1 2003 through September 30 2004).**

	ONPS Parkbase	NPF Settlement	Hoegh Settlement	Fee Demo	NRPP	Total
Program						
Coordinator	87,475					87,475
Payroll		43,849	45,898	8,958	170,276	268,981
Travel		4,497		10,845	4,530	19,872
Transportation		5,518		15,572	18,700	39,789
Food		754	5,720	2,795	11,395	20,664
Veterinary care		35	6,160	10,090	3,148	19,433
Supplies		-7,268	1,435	33,795	41,959	69,921
Perimeter fence				9,726		9,726
Eagle removal				4,920	67,475	72,395
Fox Meeting		2,521		796	10,437	13,754
Veg. map					10,000	10,000
Total	87,475	49,906	59,212	97,497	337,920	632,011



## **Budget**

A total of approximately \$632,000 was spent by the NPS on island fox recovery on the northern Channel Islands in fiscal year 2004 (Table 22), and a variety of funding sources contributed to the effort. Monies from the Natural Resource Preservation Program comprised the largest single NPS funding source, at \$337,920.

Captive breeding costs totaled approximately \$467,422, and included the full costs of island fox care on San Miguel and Santa Rosa Islands, as well as the costs of food and vet care on Santa Cruz Island. The remainder of the costs for captive breeding on Santa Cruz Island were borne by the Nature Conservancy, which also funded the bulk of golden eagle removal in 2004 and the costs of radiotelemetry monitoring of wild Santa Cruz Island foxes. From July 2004 – June 2005, TNC spent over \$250,000 on captive breeding and wild fox monitoring, and approximately \$200,000 on golden eagle removal (S. Morrison, TNC, pers. comm.).

In 2004 the NPS continued its support of the annual fox recovery team meeting, built perimeter fences for the captive facilities on Santa Rosa and San Miguel, and, along with the Institute for Wildlife Studies, funded development of a vegetation habitat map for Santa Cruz and San Miguel Islands.

## **Future Costs**

Estimated costs to NPS for island fox recovery actions in fiscal year 2005 total close to \$700,000 (Table 23). Anticipated changes from previous years include increasing personnel costs due to close to increased staffing levels, increased costs for veterinary care, and needed improvements in aging pens and facilities. Additionally, NPS and the Nature Conservancy will fund another intensive golden eagle removal effort expected to cost approximately \$350,000 (of which TNC will pay \$200,000).

Available funding sources include a new parkbase increase for island fox recovery (\$477,000), settlement monies from environmental contaminant cases, and the third and final year of a Natural Resource Preservation Program project (\$251,000).

**Table 23. Anticipated cost to NPS of island fox recovery actions in fiscal year 2005.**

Category	Cost
Personnel	371,762
Remote duty pay, island perdiem, travel	24,138
Transportation (flights)	45,000
Food for island foxes	32,100
Vet exams and care	30,000
Annual fox meeting	10,000
Eagle removal	150,000
Supplies	35,000
Pen improvements	30,200
Eagle DNA study	21,000
Eagle prey remains study	9,000
Total	698,000

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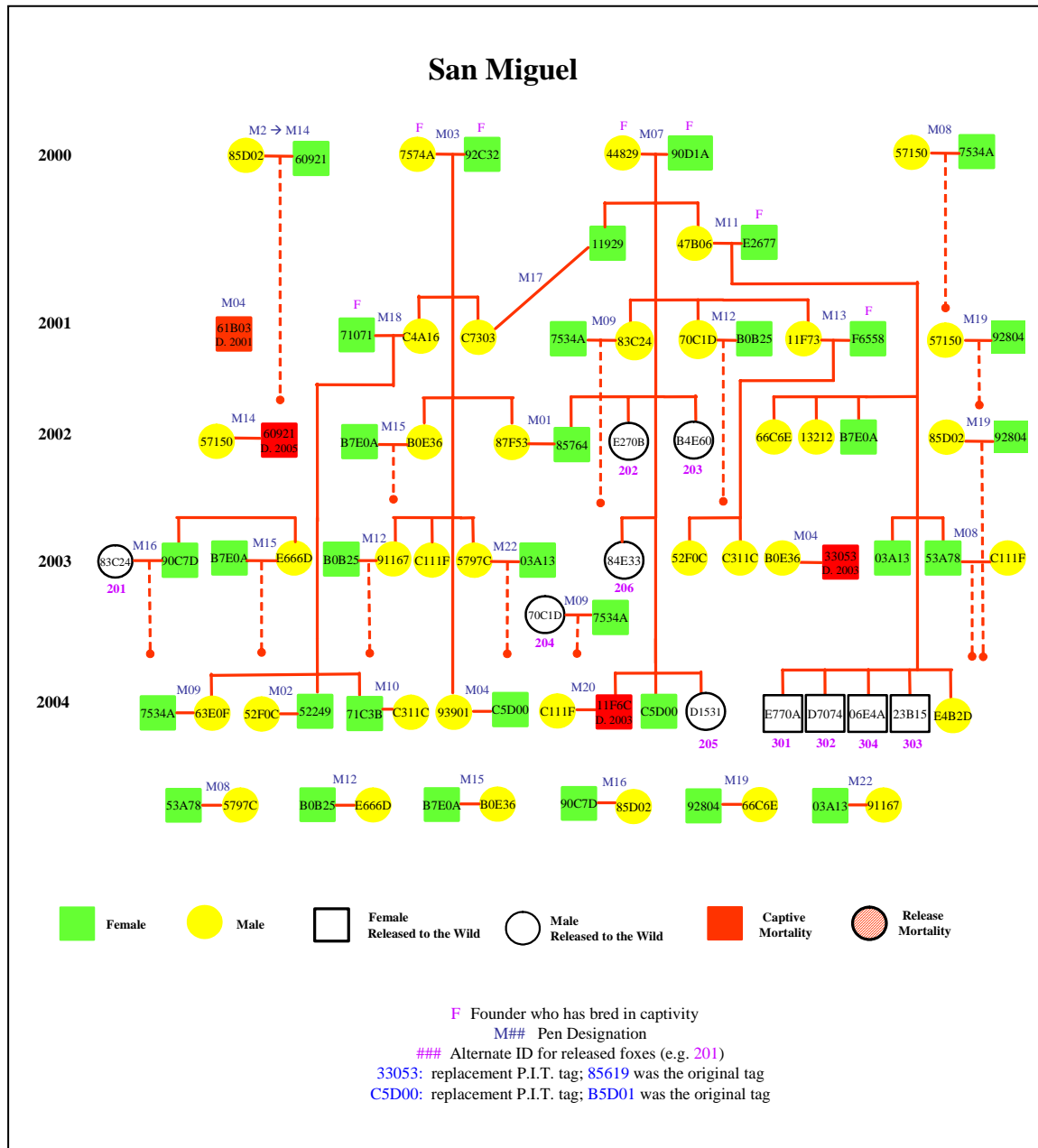
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## **Appendix A      Breeding Charts and Lists of Foxes in Captivity**



**Figure 9. Breeding and pedigree chart for captive San Miguel Island foxes.**

**Table 24. Island foxes in captive breeding facility on San Miguel Island.**

Pen	ID	Sex	Age	Born	Sire	Dam	Capture Date	Capture Area
M01	87F53	M	3	Captive	7574A	92C32		
	85764	F	3	Captive	44829	90D1A		
M02	52F0C	M	2	Captive	11F73	F6558		
	52249	F	1	Captive	C4A16	71071		



Pen	ID	Sex	Age	Born	Sire	Dam	Capture Date	Capture Area
M03	7574A	M	7	Wild			5/14/1999	Willow Canyon
	92C32	F	7	Wild			5/17/1999	Willow Canyon
M04	93901	M	1	Captive	7574A	92C32		
	C5D00	F	1	Captive	44829	90D1A		
M07	90D1A	F	7	Wild			9/2/1999	Willow Canyon
	44829	M	7	Wild			9/4/1999	Willow Canyon
M08	53A78	F	2	Captive	47B06	E2677		
	5797C	M	2	Captive	7574A	92C32		
M09	7534A	F	12	Wild			9/4/1999	Nidever Canyon
	63E0F	M	1	Captive	C4A16	71071		
M10	71C3B	F	1	Captive	C4A16	71071		
	C311C	M	2	Captive	11F73	F6558		
M11	47B06	M	5	Captive	44829	90D1A		
	E2677	F	7	Wild			9/11/1999	Willow Canyon
M12	E666D	M	2	Captive	C4A16	71071		
	B0B25	F	6	Wild			9/28/1999	Nidever Canyon
M13	11F73	M	4	Captive	44829	90D1A		
	F6558	F	6	Wild			10/4/1999	Green Mountain
M14	60921 <sup>3</sup>	F	7	Wild			9/24/1999	Green Mountain
	57150	M	7	Wild			10/4/1999	Green Mountain
M15	B0E36	M	3	Captive	7574A	92C32		
	B7E0A	F	3	Captive	47B06	E2677		
M16	85D02	M	6	Wild			9/17/1999	Cardwell
	90C7D	F	2	Captive	C4A16	71071		
M17	11929	F	5	Captive	44829	90D1A		
	C7303	M	4	Captive	7574A	92C32		
M18	71071	F	6	Wild			8/23/1999	Cardwell
	C4A16	M	4	Captive	7574A	92C32		
M19	66C6E	M	3	Captive	47B06	E2677		
	92804	F	13	Wild			10/24/1999	Willow Canyon
M20	C111F	M	2	Captive	7574A	92C32		
	11F6C <sup>4</sup>	F	1	Captive	44829	90D1A		
M21	E4B2D	M	1	Captive	47B06	E2677		
	13212	M	3	Captive	47B06	E2677		
M22	03A13	F	2	Captive	47B06	E2677		
	91167	M	2	Captive	7574A	92C32		

<sup>1</sup>Pens M01-M11 are at Willow Canyon site; pens M12-M22 are at Brooks Canyon site.

<sup>2</sup>In years, as of spring 2005.

<sup>3</sup>Female 60921 died in captivity April 9, 2005, perhaps due to complications from dystocia (difficult birth); 2 dead pups were found in her pen.

<sup>4</sup>Female 11F6C died in captivity April 28, 2005, of undetermined causes. On April 23 she had given birth to 3 pups, none of which survived.

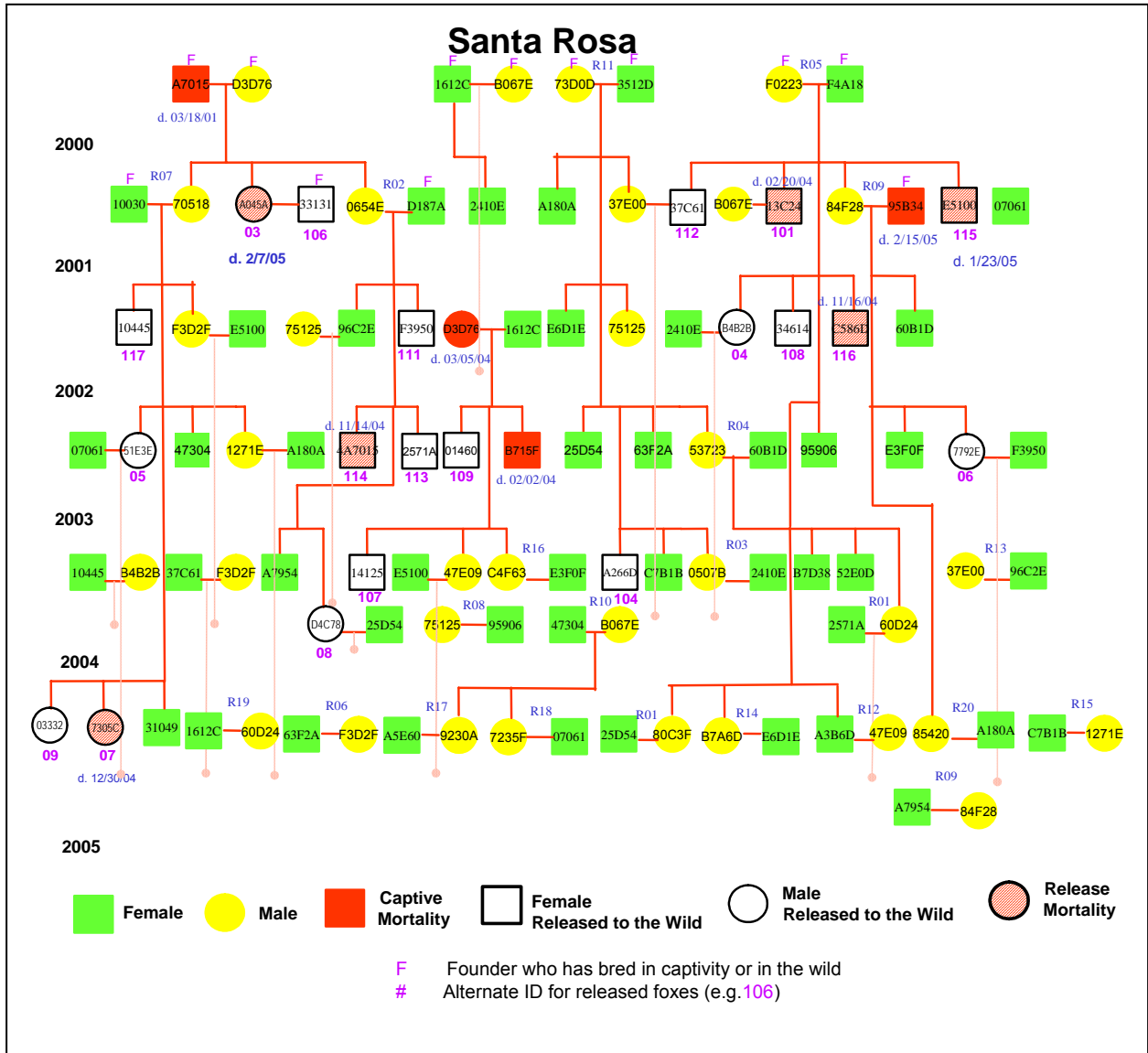


Figure 10. Breeding and pedigree chart for captive Santa Rosa Island foxes.

Table 25. Island foxes in captive breeding facility on Santa Rosa Island.

Pen <sup>1</sup>	ID	Sex	Age <sup>2</sup>	Born	Sire	Dam	Capture Date	Capture Area
R01	80C3F	M	1	Captive	F0223	F4A18		
R01	25D54	F	3	Captive	73D0D	3512D		
R02	0654E	M	5	Captive		A7015		
R03	0507B	M	2	Captive	73D0D	3512D		
R03	2410E	F	5	Captive		1612C		
R04	53723	M	3	Captive	73D0D	3512D		

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Pen <sup>1</sup>	ID	Sex	Age <sup>2</sup>	Born	Sire	Dam	Capture Date	Capture Area
R04	60B1D	F	4	Captive	84F28	95B34		
R05	F0223	M	7	Wild			4/6/2000	Smith Highway
R05	F4A18	F	6	Wild			3/29/2000	Smith Highway
R06	63F2A	F	3	Captive	73D0D	3512D		
R06	F3D2F	M	4	Captive	70518	10030		
R07	10030	F	7	Wild			4/5/2000	Smith Highway
R07	70518	M	5	Captive		A7015		
R08	75125	M	4	Captive	73D0D	3512D		
R08	95906	F	3	Captive	F0223	F4A18		
R09	84F28	M	5	Captive		F4A18		
R09	A7954	F	2	Captive	0654E	D187A		
R10	47304	F	3	Captive	70518	10030		
R10	B067E	M	7	Wild			3/26/2000	Smith Highway
R11	3512D	F	7	Wild			11/5/2000	Skunk Point
R11	73D0D	M	6	Wild			7/24/2000	Torrey Pines
R12	A3B6D	F	1	Captive	F0223	F4A18		
R12	47E09	M	2	Captive	D3D76	1612C		
R13	37E00	M	5	Wild			9/9/2000	Skunk Point
R13	96C2E	F	4	Captive	0654E	D187A		
R14	B7A6D	M	1	Captive	F0223	F4A18		
R14	E6D1E	F	4	Captive	73D0D	3512D		
R15	C7B1B	F	2	Captive	73D0D	3512D		
R15	1271E	M	3	Captive	70518	10030		
R16	C4F63	M	2	Captive	D3D76	1612C		
R16	E3F0F	F	3	Captive	84F28	95B34		
R17	A5E60	F	1	Wild	A045A	33131	10/19/2004	Windmill Canyon
R17	9230A	M	1	Captive	B067E	47304		
R18	7235F	M	1	Captive	B067E	47304		
R18	07061	F	7	Wild			5/14/2001	Windmill Canyon
R19	60D24	M	2	Captive	53723	60B1D		
R19	1612C	F	6	Wild			3/23/2000	Smith Highway
R20	A180A	F	5	Wild			10/24/2000	Skunk Point
R20	85420	M	1	Captive	84F28	95B34		
R21A	31049	F	1	Captive	70518	10030		
R21B	52E0D	F	2	Captive	53723	60B1D		
R23A	B7D38	F	2	Captive	53723	60B1D		
R23B	D187A	F	7	Wild			4/5/2000	Smith Highway

<sup>1</sup>Pens R01-R12, R21-R23, and RQ1-2 are at Windmill Canyon site; pens R13-R20 are at Caballo del Muerto site.

<sup>2</sup>In years, as of spring 2005.

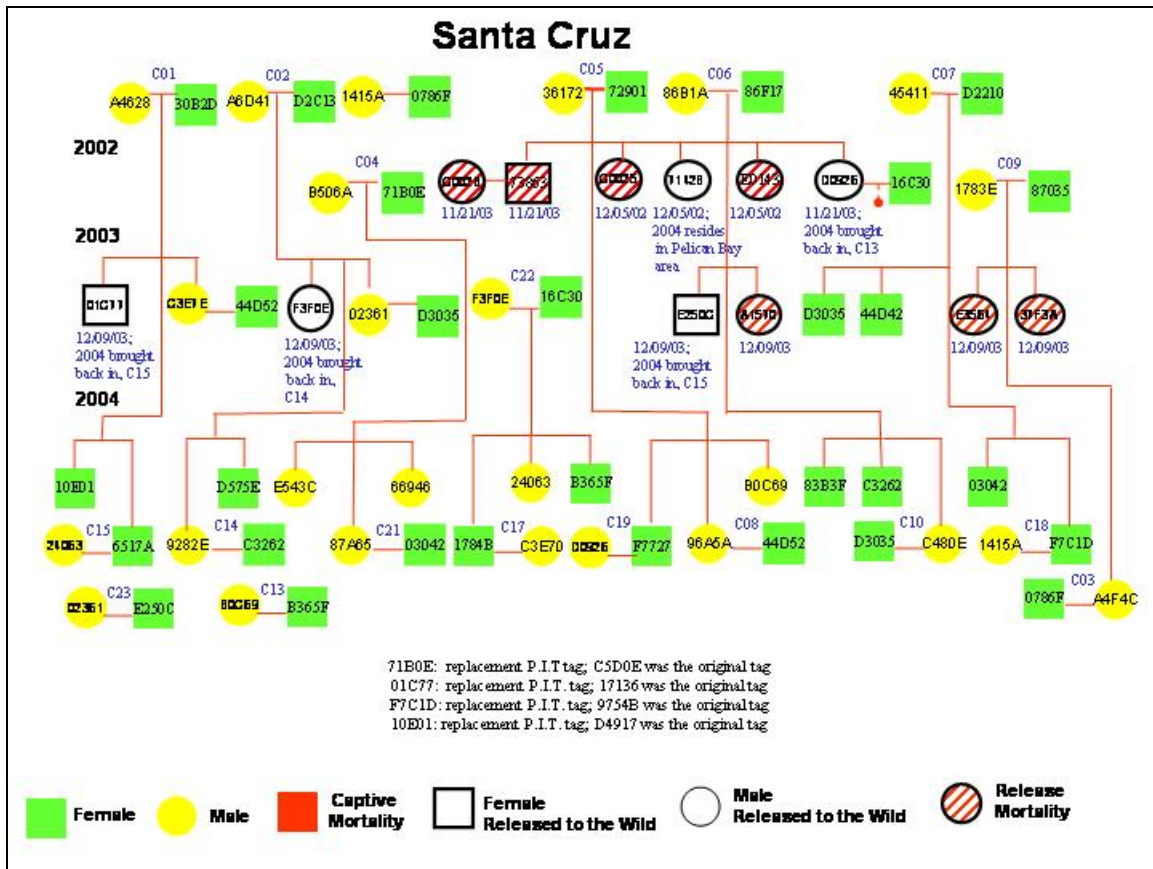


Figure 11. Breeding and pedigree chart for Santa Cruz Island foxes.

Table 26. Island foxes in captive breeding facility on Santa Cruz Island.

Pen <sup>1</sup>	PitTag	Sex	Age <sup>2</sup>	Born	Sire	Dam	Date Captured	Capture Area
C01	A4628	M	8	Wild			3/11/2002	Islay Canyon
C01	30B2D	F	6	Wild			2/27/2002	Cebada Canyon
C02	A6D41	M	5	Wild			2/27/2002	Sauces Canyon
C02	D2C13	F	5	Wild			2/27/2002	Prisoner's Marsh
C03	A4F4C	M	1	Captive	1783E	87035		
C03	0786F	F	7	Wild			3/2/2002	China Pines
C04	B506A	M	5	Wild			1/15/2003	Isthmus
C04	71B0E	F	5	Wild			1/15/2003	Isthmus
C05	72901	F	5	Wild			2/27/2002	Prisoner's Canyon
C05	36172	M	6	Wild			2/27/2002	Pelican Bay Trail

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Pen <sup>1</sup>	PitTag	Sex	Age <sup>2</sup>	Born	Sire	Dam	Date Captured	Capture Area
C06	86B1A	M	5	Wild			2/27/2002	Pozo Canyon
C06	86F17	F	5	Wild			3/10/2002	Pozo
C07	45411	M	5	Wild			3/1/2002	China Pines
C07	D2210	F	4	Wild			3/11/2002	Cebada Canyon
C08	44D52	F	2	Captive	45411	D2210		
C08	96A5A	M	1	Captive	36172	72901		
C09	1783E	M	8	Wild			12/4/2002	Coches Prietos
C09	87035	F	7	Wild			12/4/2002	Coches Prietos
C10	C480E	M	1	Captive	86B1A	86F17		
C10	D3035	F	2	Captive	45411	D2210		
C13	B0C69	M	1	Captive	36172	72901		
C13	B365F	F	1	Captive	F3F0E	16C30		
C14	9282E	M	1	Captive	A6D41	D2C13		
C14	C3262	F	1	Captive	86B1A	86F17		
C15	6517A	F	1	Captive	A4628	30B2D		
C15	24063	M	1	Captive	F3F0E	16C30		
C16	D575E	F	1	Captive	A6D41	D2C13		
C16	83B3F	F	1	Captive	86B1A	86F17		
C17	C3E7E	M	2	Captive	A4628	30B2D		
C17	1784B	F	1	Captive	F3F0E	16C30		
C18	F7C1D	F	1	Captive	45411	D2210		
C18	1415A	M	5	Wild			3/3/2002	China Pines
C19	F7727	F	1	Captive	36172	72901		
C19	D0926	M	3	Captive	86B1A	86F17		
C20	01C77	F	2	Captive	A4628	30B2D		
C20	10E01	F	1	Captive	A4628	30B2D		
C21	87A65	M	1	Captive	B506A	71B0E		
C21	03042	F	1	Captive	45411	D2210		
C22	F3F0E	M	2	Captive	A6D41	D2C13		
C22	16C30	F	4	Wild			6/6/2002	Isthmus Pen Site
C23	02361	M	2	Captive	A6D41	D2C13		
C23	E250C	F	2	Captive	86B1A	86F17		

<sup>1</sup>Pens C01-C10 are at Navy site; pens C11-C23 are at Central Valley site

<sup>2</sup>In years, as of spring 2005